no abs

Vol. XXXIII APRIL-MAY-JUNE, 1950 No. 4

THE PHILIPPINE AGRICULTURIST

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A

CONTENTS

Published by

THE COLLEGE OF AGRICULTURE
UNIVERSITY OF THE PHILIPPINES

The Philippine Agriculturist

(University of the Philippines Publications Series A)

Authors of articles appearing in THE PHILIPPINE AGRICULTURIST are severally responsible for the opinions expressed therein.

THE PHILIPPINE AGRICULTURIST is published quarterly, beginning with Volume 31, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱6.00 a year in the Philippines and $4.00 (U.S. currency) elsewhere; the price of single copies, ₱2.00 in the Philippines and $1.00 (U. S. currency) elsewhere.

Business correspondence should be addressed to the Business Manager, THE PHILIPPINE AGRICULTURIST, College, Laguna, Philippines. All remittances should be made payable to THE PHILIPPINE AGRICULTURIST.

Communications for the editor should be addressed to the Editor, THE PHILIPPINE AGRICULTURIST, College, Laguna, Philippines.

Publications sent in exchange for THE PHILIPPINE AGRICULTURIST should be addressed: Library, College of Agriculture, College, Laguna, Philippines.

Entered at the Post Office at College, Laguna, Philippines, as second-class mail matter

REPRODUCTIVE CAPACITY OF THE ORIENTAL MIGRATORY LOCUST[1]

GETULIO B. VIADO[2]
Of the Department of Entomology

WITH TWO PLATES AND ONE TEXT FIGURE

The reproductive capacity of the Oriental migratory locust, *Locusta migratoria manilensis* (Meyen), determines to some extent the amount of attention which should be directed to the control of the adults. Many farmers in the Philippines believe that the locust lays only one pod of eggs in its entire lifetime and that the pod contains as many as 100 eggs. This is one of the reasons why some farmers pay little attention to swarms in which the females have already oviposited. Their efforts are directed mainly towards the hoppers, disregarding the adults almost entirely, except in places where the adults are caught principally for food.

It is now known that the locust lays more than one pod of eggs in its lifetime, but no reasonably accurate basis of estimate of the number of eggs a female is able to lay has been found for this species in the Philippines.

Jones and Mackie (1913), in their study of the Oriental migratory locust, mentioned that the insect lays eggs only once in its lifetime and that the number of eggs each cluster contains varies from 60 to 80. No data, however, were presented by the authors to support their claim.

Gonzales (1932) found that the locust lays as many as five egg-masses during its lifetime, the number of eggs to a pod varying from 12 to 32. This investigator reported that in no case was he able to find as many as 40 eggs laid at one time. Even field examination, according to him, failed to show more than 32 eggs to a pod. In the laboratory, he found that 68 was the maximum total number of eggs laid by a female.

The present study was undertaken to determine the reproductive capacity of the Oriental migratory locust, and to gather more data relative to the life-history of this insect.

Portions of the data presented in this article were originally gathered several years ago. The greater part of the work was conducted in the laboratory of the Department of Entomology, College of Agriculture, College, Laguna, Philippines.

MATERIALS AND METHODS

The specimens used in the first part of this study were collected in La Carlota and Kabankalan, province of Negros Occidental, Philippines, in 1933. The life-history studies were conducted in La Carlota and the field studies, in both localities during that year. The materials used from these sources are designated in this paper as lot 1. The stock of lot 2 was secured as eggs from Oriental Misamis, Mindanao, in January, 1948, and reared

[1]Experiment Station Contribution No. 1547.

[2]The author wishes to acknowledge his indebtedness to Dean L. B. Uichanco for valuable suggestions.

THE PHILIPPINE AGRICULTURIST, VOL. 33, NO. 4, APRIL, MAY, JUNE, 1950.

at the Department of Entomology, College of Agriculture. The examination of the ovaries was conducted with the aid of a binocular microscope. In making ovariole counts, each ovariole was detached from the ovary to prevent confusion in counting. The drawings were made with the aid of a camera lucida.

The life-history studies were conducted with materials from the first lot. Screen cages 30.5 cm. by 30.5 cm. by 45.7 cm. (12 by 12 by 18 inches) with one sliding glass side were used. A tin can about 15 cm. (6 inches) in diameter and about 10 cm. (4 inches) deep was filled with moist soil and fitted into a circular hole at the bottom of each cage. Sugar-cane leaves were used exclusively as feed for the insect. The cages were placed in the open yard outside the building, where they received direct sunlight from about 6:30 A. M. to about 4:00 P. M. The feed was changed once daily, except during the hot months, when it was necessary to change it twice a day, in the morning and late in the afternoon. Only one pair of locusts was placed in each cage. Dead males were replaced during the course of the study. Copulations during the day and part of the night were recorded.

Inasmuch as the locust covered its oviposition hole, it was difficult to determine whether or not a female had laid eggs without systematically looking for the egg-pods in the soil. In the course of the study, the writer noted a more or less reliable criterion for determining whether or not a female had laid eggs. A portion of the frothy mass exuded with the eggs clung to the tip of the abdomen for some time after oviposition. The presence of the fresh coating of this substance at the tip of the abdomen, therefore, is an indication that the insect has just laid eggs. By making use of this phenomenon as a guide, the tedious operation of examining the soil daily was dispensed with.

The depth of oviposition holes was measured in sugar-cane fields with clay-loam soil from samples taken at random within an area of about one hectare.

DISCUSSION OF RESULTS

Ovariole counts

The number of ovarioles in each ovary in either lot was not constant. While some females had the same number of ovarioles in both ovaries, most of them had an uneven number, the difference ranging from 1 to 5.

In the first lot (table 1) counts made on 1,210 females showed that there was no difference in each pair of ovaries between the means of the number of ovarioles. Each ovary contained an average of 32.89 ∓ 0.08 ovarioles, or a total of 65.8 ∓ 0.14 for each female. Only one out of the 1,210 females examined had 102 ovarioles, 50 in the right ovary and 52 in the left. This was an exceptional case, as two-thirds of the adults had 32 to 33 ovarioles to each ovary, or a total of 64 to 66 to the female. The lowest number counted was 25 for the right ovary and 22 for the left, or a total of 47 ovarioles. The average female from this lot (lot 1), therefore, could lay a maximum of 66 eggs at one laying.

In lot 2, the mean number of ovarioles in the right ovary, based on 106 adult females, was 39.8 ∓ 0.42, while that in the left was 39.4 ∓ 0.46. The difference between the two means was only 0.4, which is insignificant. The total for the average female was 79.4 ∓ 0.87. This figure is much higher

than that in lot 1 (65.8 ∓ 0.14), which means that the females in lot 2 contained more ovarioles than those in lot 1. The maximum possible number of eggs that could be laid by the average female for this lot, therefore, was 80. In the case of the hoppers, the average number of ovarioles for the right ovary was 44.3 ∓ 0.56 and for the left ovary, 44.2 ∓ 0.59. The difference between these two means was only 0.1, which is very insignificant.

A comparison between the number of ovarioles in each ovary in the two lots (table 2) showed a highly significant difference of 6.9 between the means of the right ovaries. The difference of 6.5 between those of the left ovaries is, likewise, highly significant. The results show that the adults in lot 1, collected in 1933, which, according to Uichanco (1936), and Uichanco and Gines (1937), was a locust year, contained less number of ovarioles than those in lot 2 which were collected in 1948, a nonlocust year.

In this connection, it is of interest to note the following report from Rubtzov's studies of Siberian grasshoppers (1934): "It appears that the total number of eggs, of egg-tubes, and of eggs in each tube are very unstable quantities, varying in different genera and species, as well as in individuals belonging to the same species but inhabiting different parts of its area". This same author stated that in *Locusta migratoria rossica* from Central Russia, there were 53 egg-tubes in one ovary and 52 in the other, with 12 to 13 eggs in each, giving a potential fertility of 1,260 to 1,365 eggs. This potential fertility, he said, is more or less stable in different species of grasshoppers. He reported further that in the Siberian grasshoppers he studied, there was no correlation among the potential fertility, actual fertility, and the abundance of the species in nature, the greatest fertility being met within those species which occurred rarely; that the potential fertility cannot be regarded as an index of the potential increase in the number of a species, but merely as an indication of the degree of the controlling action of the environment; that the coefficient of destruction by the controlling factors must be higher for the relatively rare species with higher potential fertility than for those which are more abundant in nature but which have less potential fertility; that the number of ovarioles and the number of ova in each ovariole vary according to food and climatic and microclimatic conditions of each habitat. He concluded that in the species with 10 or more ovarioles, the number varies in different parts of the distribution area, decreasing towards the center of the area with increasing warmth and dryness and increasing towards the colder and humid border of the area.

In lot 2, the fifth-instar hoppers contained more ovarioles than the adults. The ovariole counts are shown in table 1. In the adult, the average number of ovarioles in the right ovary was 39.8 ∓ 0.42, while in the fifth-instar hopper it was 44.3 ∓ 0.56. The figures corresponding to the left ovary were 39.4 ∓ 0.46 for the adult, and 44.2 ∓ 0.59 for the hopper. The differences between the means (table 2) were significant, indicating that the fifth-instar hopper contained more ovarioles than the adult.

Roonwal (1946), in his studies on the number of ovarioles in the adult desert locust, *Schistocerca gregaria* (Forskål), based on 49 females, found that the number of ovarioles in the right ovary varied from 43 to 83 with a mean of 57.3, while those in the left ovary varied from 40 to 81 with a mean of 57.2 He reported that the number of ovarioles in the right and

left ovaries in the same female usually differed. According to this investigator, some of the ovarioles, even as early as in the fourth-instar hoppers, were markedly smaller than the others in the same ovary. This explains, he said, why the number of eggs laid was not equal to the number of ovarioles in an ovary.

Roonwal (1946) explains the unequal development of the ovarioles as probably due to nutrition and competition for space, which condition is accentuated during the maturation of the ovaries. The result, therefore, according to this author, is the complete resorption of a number of ovarioles leading to asymmetry in the ovaries, which asymmetry is absent in hoppers and evidently acquired in the late fifth-stage hopper or in the young adult, and is accentuated with maturity in the adult. In the eight hoppers he dissected (two specimens from each of the second, third, fourth and fifth instars), he found equal numbers of ovarioles in the left and right ovaries. This condition was not found in the present study. Of the 52 fifth-instar hoppers examined, only 6 exhibited equal numbers of ovarioles; the remaining 46 had uneven numbers.

In his study of seven species of Transvaal Acrididae, Nolte (1939) reported that there was a slight interspecific variation in the number of ovarian tubules.

Development of the first two ova in the ovariole

Table 3 and fig. 1 show the summary of measurements in millimeters of the oldest and next oldest ova of each ovariole at various ages of the

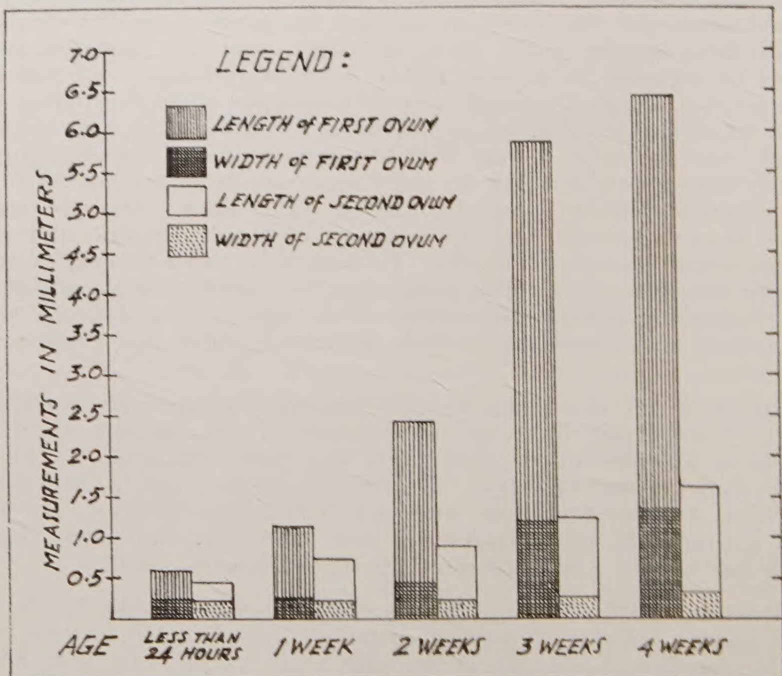


Fig. 1—Summary of measurements of the oldest and next oldest ova of each ovariole.

adult female. The table shows that the oldest ovum in an ovariole grew much faster than the one preceding it in the same tubule. The size of the oldest ovum increased rapidly during the first three weeks, after which growth slowed down abruptly, as shown by the small increase in size in the fourth week. The fastest growth was in the third week, when the increase in length was 3.45 millimeters and that in width, 0.75 millimeter. The increase in length of the oldest ovum at the end of the first week was 0.57 millimeter; that of the second ovum was 0.29 millimeter. The corresponding figures at the end of the second week were 1.28 millimeters and 0.11 millimeter, respectively. For the three-week-old ovarioles, the figures were 3.45 millimeters for the first ovum and 0.34 millimeter for the second. The increase in length of the first ovum in the fourth week dropped abruptly to 0.56 millimeter, while that of the second ovum increased from 0.34 in the third week to 0.38 millimeter in the fourth.

In the case of the second ovum, the increase in length at the end of the first week was 0.29 millimeter. There was no increase in width. At the end of the second week, the increase in length dropped to only 0.18 millimeter. No increase in diameter was likewise noted. The increases in length and diameter corresponding to the third week were 0.34 and 0.03 millimeter, respectively. At the end of the fourth week, the increase in length was 0.38 and that in the diameter was 0.07 millimeter.

It is interesting to note in table 5 that the average length of a newly laid egg was 6.1 ∓ 0.02 millimeters and the average width, 1.3 ∓ 0.00 millimeters. These figures are very close to those of the first ovum in the ovarioles at the end of the third and fourth weeks as shown in table 3, namely, 5.88 ∓ 0.02 millimeters long and 1.20 ∓ 0.01 millimeters wide at the end of the third week, and 6.44 ∓ 0.03 millimeters long and 1.37 ∓ 0.01 millimeters wide at the end of the fourth week. This observation shows that the oldest ova in the ovarioles at the end of the third week were apparently already mature and ready for oviposition. It is probable that the female is able to withhold her load of mature ova in her ovaries for some time after they were ready for laying. In table 6 it appears that there is a wide range in the period of development and maturity of the ova as shown by the time spent from emergence of the adult to the first oviposition, which varied from 10 to 41 days with an average of 20.0 ∓ 0.10 days, or roughly three weeks.

Condition of the ovaries of gravid and spent females

An examination of gravid females reared in the laboratory and those collected from young swarms in the field showed that not all the ovarioles in both ovaries contained fully developed ova. In lot 1, of the 314 gravid females reared in the laboratory from fifth-instar hoppers collected from the field, 307 possessed ovarioles with undeveloped first ovum, ranging from 0 to 20 in the right ovary and from 1 to 21 in the left. This same condition existed in gravid unspent females collected from swarms in the field. Specimens from lot 2 also showed the same condition.

An examination of individuals in lot 1 which had just laid a pod of eggs revealed that, in some cases, not all the mature ova were discharged in oviposition. This phenomenon was also noted in lot 2. Of 739 females examined in lot 1, 106 contained ovarioles with mature ova, ranging from 1 to 25 in the right ovary and from 0 to 7 in the left.

The above findings show that apparently not all the oldest ova in the different ovarioles of an individual female developed at the same time; for this reason, an oviposition sitting is not necessarily followed by a total clearing out of the full-grown ova. According to Uvarov (1928), whether both the ovaries of the female acridid empty themselves of all their mature eggs at the same time or not has not yet been definitely established. This same author cites Grasse who observed that in *Anacridium aegyptium*, only one or two eggs remained in their ovaries after oviposition. He also cites Coleman who observed that in the rice grasshopper, *Hieroglyphus banian*, one ovary empties after the other.

Copulations

In taking the number of times the insects mated throughout their lifetime, only observed copulations were recorded. The locust mated both during the day and at night. Based on 51 females, the number of matings ranged from 1 to 19, with an average of 6.5 ∓ 0.47. Using seven females, Gonzales (1932) observed that the number of copulations ranged from 3 to 9, with an average of 5.7. In the case of the desert locust, *Schistocerca gregaria*, Ballard, Mistikawa Eff., and El Zoheiry Eff. (1932), recorded a minimum of 1 and a maximum of 53, or an average of 18 copulations.

Depth of oviposition holes

It was noted that the direction of the oviposition holes with respect to the surface of the ground varied considerably from perpendicular to angular or slanting. The depth of the hole as reported in the present paper was taken by measuring the total length of the hole from the surface of the ground to the bottom of the hole, irrespective of the direction of the hole.

At first, it was thought that the length of the egg-pod also indicated the depth of oviposition, but it was found in the course of observation that the egg-pod, in most cases, did not occupy the entire length of the oviposition hole. Some pods were found occupying only the bottom part of the hole, while some females laid their eggs some distance from the bottom of the hole.

The average depth of oviposition holes in clay-loam soil (table 5) was 67.2 ∓ 0.42 millimeters. The maximum recorded was 85 and the minimum, 42 millimeters. According to Jones and Mackie (1913), the depth of the oviposition holes varied according to the character of the soil. These authors reported that in compact alluvial soil the hole is usually about 40 millimeters deep, while in loose sandy soils they may be 70 or even 80 millimeters deep. However, no data to support their claim were presented. Gonzales (1932) reported that the oviposition hole of the locust is about 60 millimeters deep.

Size of egg-pod and newly laid egg

A study of 334 egg-pods reared in the laboratory, exclusive of the "stopper" (table 5), showed that the length varied considerably from a minimum of 10.0 to a maximum of 38.5 millimeters, or an average of 25.5 ∓ 0.28 millimeters. The width of the pod varied from 3.5 to 7.0, with a mean of 5.4 ∓ 0.03 millimeters.

Based on 393 egg-pods collected from the field, the length varied from 16.0 to 66.0, with a mean of 41.0 ∓ 0.39 millimeters. The figures corre-

sponding to the width of the pod were 5.5 to 9.0, with a mean of 7.2 ∓ 0.03 millimeters. Uvarov (1928) reported that in *Locusta migratoria* L., the length of the egg-pod, including the "stopper", varied from 58 to 75 millimeters.

The maximum length of a newly laid egg based on 324 eggs from 15 egg-pods was 6.7 millimeters; the minimum was 5.1. The average length was 6.1 ∓ 0.02 millimeters. The width varied from 1.1 to 1.7 with a mean of 1.3 millimeters.

Number of eggs to a pod

Counts of the number of eggs to a pod (table 4) showed an average of 39.4 ∓ 0.10. The highest number noted was 65; the lowest, 3. In the case of those collected from the field the average, based on 447 egg-pods, was 47.6 ∓ 0.46. The highest number noted was 67; the lowest, 5.

Jones and Mackie (1913) reported that each cluster of eggs contained from 60 to 80 eggs. These figures are rather high compared with those obtained in the present study. No data were presented by these authors. Of the 447 egg-pods collected from the field, there was only one case where 67 eggs were counted in a pod. According to Gonzales (1932), the number of eggs laid in each hole varied from 12 to 32. He obtained these figures by digging out egg-pods both in the laboratory and in the field. Unfortunately, the number of egg-pods examined was not given, so that it might be possible that most of those pods counted contained exceptionally few eggs.

Uvarov (1928) reported that in *Locusta migratoria*, the number of eggs to a pod varied from 55 to 115. Roonwal (1936) found that in the African migratory locust, *Locusta migratoria migratorioides* R. and F., the number of eggs varied from 22 to 81. No data were presented to support the claims of these authors. Ballard, Mistikawa Eff., and El Zoheiry Eff. (1932) reported that in the desert locust, *Schistocerca gregaria*, the number of eggs to a pod varied from 19 to 53, with an average of 38. Drake, Decker, and Tauber (1945) found that the average number of eggs to a pod was 69.7 for *Melanoplus bivittatus* (Say), 88.8 for *M. differentialis* (Thom.), and 19.6 for *M. mexicanus* (Sauss.).

Number of egg-pods laid

The number of egg-pods laid by the locust throughout its lifetime, on the basis of 51 females, varied from 2 to 13, with a mean of 6.1 ∓ 0.39 (table 4). Gonzales (1932), using seven females, found the number of egg-pods laid to vary from 1 to 5, with an average of 3.1. In *Locusta migratoria migratorioides*, Johnston and Maxwell-Darling (1931) reported that in Sudan, 11 egg-pods were noted in one female. Uvarov (1928) cited Faure, who noted that in the South African brown locust, *Locustana pardalina*, up to 14 egg-pods were laid by one female. Ballard, Mistikawa Eff., and El Zoheiry Eff. (1932) reported 1 to 6 egg-pods, with an average of 2 for the desert locust, *Schistocerca gregaria*, in Egypt.

Total number of eggs laid

There is a wide variation in the total number of eggs a female locust lays in its entire lifetime (table 2). The number ranged from 56 to 489, with an average of 241.2 ∓ 18.05 eggs. Gonzales (1932) in a study of seven

females, found that the maximum number of eggs laid by a female in the laboratory was only 68. Drake, Decker, and Tauber (1945) reported that *Melanoplus bivittatus* laid 129 eggs and *M. differentialis*, 128. Although the average number of eggs to a pod was high (69.7 and 88.8, respectively), the total number of eggs laid by a female was small.

Infertile eggs

Of a total of 50 egg-pods reared in the laboratory and collected from the field, 39 contained infertile eggs, ranging in number from 1 to 5 to each pod. All the eggs in the remaining 11 pods hatched. The unhatched eggs were left in the container for over a week after the last fertile egg in each pod had hatched. An examination under the microscope revealed that there was no embryo, although the eggs appeared normal.

Sexual maturity

The age of the female at sexual maturity, which is the number of days from emergence to laying of the first pod of eggs (table 6), varied considerably from 10 to 41 days, with an average of 20.0 ∓ 0.10 days. This wide variation may be attributed in part to the uneven development of the ovaries among the females. It is apparent that while some females attained sexual maturity early (10 days), others did not attain it until after one month or over. Johnston and Maxwell-Darling (1931) reported that in *Locusta migratoria migratorioides*, eggs were laid 12 days after the last molt. In *Schistocerca gregaria*, Ballard, Mistikawa Eff., and El Zoheiry Eff. (1932) reported that the age at sexual maturity varied from 23 to 113 days, with an average of 59 days.

Fecundity

The period of fecundity as used in this paper is the period from the first oviposition to the death of the female. It was observed that many females which died contained mature ova in their ovaries. Some females died within 24 hours after laying their last pod of eggs.

The period of fecundity for the 51 females studied (table 6) ranged from 9 to 80 days. The average period was 32.9 ∓ 2.02 days. Gonzales (1932) reported from 1 to 37 days, or an average of 13.1 days for the seven females he studied. Johnston and Maxwell-Darling (1931) observed that one female of *L. migratoria migratorioides* laid a total of 11 egg-pods within 30 days. These authors also reported that this species when reared in cages had a very much longer period of fecundity. According to Uvarov (1928), the female Acrididae lives much longer in captivity than in the field and "can lay eggs almost indefinitely."

Longevity of adult female

The life of the adult female (table 6) ranged from 26 to 92 days, or an average of 52.7 ∓ 2.07 days. It is evident from this table that nearly all the 51 females lived one month or longer. One female lived for 3 months before it died.

Post-mortem examination of ovaries

An examination of the ovaries of spent females which died during the course of the life-history studies showed that the ovaries apparently were still in condition to produce an indefinite number of eggs even after

laying so many egg-pods. In some specimens dissected, the ovaries contained mature ova apparently ready to be oviposited. The ovarioles in all the ovaries examined contained ova in various stages of development, the normal condition existing in gravid females.

Life history

Table 6 shows the data on the life history of the locust obtained in this study. The incubation period, based on 29 egg-pods, ranged from 16 to 18 days, with an average of 17.0 ∓ 0.19. It was observed that all the eggs in one egg-pod, provided they were all fertile and the soil was moist, hatched within 12 hours. In most of the pods all the fertile eggs hatched within two hours.

The duration of the various stadia was very variable. The highest were in the first and fifth stadia and the lowest were in the third and fourth. The following were the duration in days of the stadia and other stages in the development of the insect:

First stadium. Based on 169 individuals; maximum 15, minimum 5, average 8.2 ∓ 0.12 days.

Second stadium. Based on 165 individuals; maximum 14, minimum 4, average 7.6 ∓ 0.14 days.

Third stadium. Based on 165 individuals; maximum 11, minimum 4, average 6.4 ∓ 0.11 days.

Fourth stadium. Based on 152 individuals; maximum 9, minimum 5, average 6.3 ∓ 0.08 days.

Fifth stadium. Based on 141 individuals; maximum 12, minimum 7, average 8.6 ∓ 0.09 days.

Age of adult at sexual maturity. Based on 51 individuals; maximum 41, minimum 10, average 20.0 ∓ 0.10 days.

Period of fecundity. Based on 51 individuals; maximum 80, minimum 9, average 32.9 ∓ 2.02 days.

Longevity of female. Based on 51 individuals; maximum 92, minimum 26, average 52.7 ∓ 2.07 days.

From the figures given above, the average life cycle of the locust was 74.1 days. On this basis, the insect could possibly have four or five generations a year. The average nymphal stage was 37.1 days, and the average adult stage of the female was 52.7 days. The average length of the life span of the female, therefore, was about 106.8 days.

SUMMARY AND CONCLUSIONS

1. Based on 1,210 individuals from lot 1, which were collected during a locust year, the average number of ovarioles in either ovary was 32.89 ∓ 0.08. The number in the right ovary ranged from 25 to 52 and in the left, from 22 to 50. The total for the average female was 65.8 ∓ 0.14 ovarioles. In lot 2, on the basis of 106 individuals, the average number of ovarioles in both ovaries was the same, the difference of 0.4 between the two means being insignificant. The range in the right ovary was 30 to 54 ovarioles, with an average of 39.8 ∓ 0.42; while that in the left was 28 to 55 ovarioles, with an average of 39.4 ∓ 0.46. The total for the average female was 79.4 ∓ 0.87.

2. The highest number of ovarioles to a female noted in lot 1 was 102 and the lowest was 47. The figures corresponding to the second lot were 108 and 60, respectively.

3. On the basis of the ovariole counts, the maximum number of eggs that an average female in lot 1 could lay in one oviposition was 66; that in lot 2 was 80.

4. Not all the first, or oldest, ova in the ovaries developed at the same rate.

5. In the fifth-instar hopper, the average number of ovarioles in the two ovaries based on 52 specimens was the same, the difference of 0.10 between the two means being insignificant. The ovarioles in the right ovary ranged from 37 to 54, with an average of 44.3 ∓ 0.56, while those in the left ranged from 38 to 56, or an average of 44.2 ∓ 0.59. The total number for the average fifth-instar female was 88.5 ovarioles.

6. The difference of 4.5 between the average number of ovarioles in the right ovary of the adults and hoppers in lot 2 was highly significant, indicating that the fifth-instar hopper contained more ovarioles in the right ovary than the adult. The same was noted in the case of the left ovaries in which a difference of 4.8 was found to be highly significant.

7. In the adult, the first, or oldest, ovum in the vitellarium grew much faster than the next or second ovum. There was a rapid increase in size of the first ovum in the first three weeks of the adult stage, after which growth became very slow. The fastest growth was in the third week when the increase in length was 3.45 millimeters and the increase in width was 0.75 millimeter. The increases in growth corresponding to those of the first and second weeks were 0.57 and 0.01 millimeter, and 1.28 millimeters and 0.19 millimeter, respectively.

8. The increase in size of the next succeeding ovum was rather irregular. It exhibited an increase of only 0.29 millimeter in length and no increase in width at the end of the first week. The increase in length dropped to only 0.18 millimeter at the end of the second week, with no increase in diameter. In the third week the increases were 0.34 and 0.03, and in the fourth week, 0.38 and 0.07 millimeter, respectively.

9. The differences between the ovariole counts in the two lots were highly significant, indicating that the females in lot 1, which were collected during a locust year, contained fewer ovarioles than those in lot 2, which were collected during a nonlocust year.

10. The total number of observed copulations varied from 1 to 19, with an average of 6.5 ∓ 0.47.

11. The depth of oviposition holes ranged from 42 to 85, with an average of 67.2 ∓ 0.42 millimeters.

12. The length of the egg-pod could not be indicated by the depth of the oviposition hole. The length of egg-pod ranged from 10.0 to 38.5, with an average of 25.5 ∓ 0.28 millimeters. While some pods were laid at the bottom of the hole, others were laid some distance from it. The width or diameter of the pod varied from 3.5 to 7.0, with an average of 5.4 ∓ 0.03 millimeters.

13. The number of eggs to a pod varied from 3 to 65, with an average of 39.4 ∓ 0.10.

14. The number of eggs to a pod is not an indication of the number of ovarioles in the ovaries. Not all the first, or oldest, ova in the ovaries

developed at the same rate, and, also, not all the mature ova were laid by the female during oviposition.

15. The number of egg-pods laid by a female ranged from 2 to 13, with an average of 6.1 ∓ 0.39.

16. The total number of eggs laid ranged from 56 to 489, with an average of 241.2 ∓ 18.05.

17. The sexual maturity of the locust (emergence to first oviposition) ranged from 10 to 41 days, with an average of 20.0 ∓ 0.10 days.

18. The period of fecundity ranged from 9 to 80 days, with an average of 32.9 ∓ 2.02 days.

19. The longevity of the adult female range from 26 to 92 days, with an average of 52.7 ∓ 2.07 days.

20. The incubation period of the eggs ranged from 16 to 18 days, with an average of 17.0 ∓ 0.19 days.

21. The range and average of the duration of the various nymphal stages were: first stadium: 5 to 15, average 8.2 ∓ 0.12 days; second stadium: 4 to 14, average 7.6 ∓ 0.14 days; third stadium: 4 to 11, average 6.4 ∓ 0.11 days; fourth stadium: 5 to 9, average 6.3 ∓ 0.08 days; fifth stadium: 7 to 12, average 8.6 ∓ 0.09 days.

LITERATURE CITED

BALLARD, E., A. M. MISTIKAWA EFF., AND M. S. EL ZOHEIRY EFF. 1932. The desert locust, *Schistocerca gregaria* Forsk., in Egypt. Ministry of Agriculture Tech. Sci. Serv. Bull. 110–149 p. *Pl. 1–43.*

DRAKE, C. J., G. C. DECKER, AND O. E. TAUBER. 1945. Observations on oviposition and adult survival of some grasshoppers of economic importance. Iowa State College Jour. Sci. **19**: 207–223.

GONZALES, SALUSTIANO S. 1932. Further studies of the biology of the migratory locust (*Pachytylus migratorioides* Reiche and Fairm.), Locustidae, Orthoptera. Philippine Jour. Agric. **3**: 1–38. *Pl. 1–7.*

JOHNSTON, H. B., AND R. C. MAXWELL-DARLING. 1931. On the occurrence in the Sudan of *Locusta migratorioides* Rch. and Fairm., and its associated phases. Bull. Entom. Res. **22**: 399–416.

JONES, C. R., AND D. B. MACKIE. 1913. The locust pest. Philippine Agric. Rev. **6**: 5–22. *Pl. 1–4; fig. 1–5.*

NOLTE, DANIEL JOHANNES. 1939. A comparative study of seven species of Transvaal Acrididae, with special reference to the chromosome complex. Jour. Entom. Soc. S. Africa **2**: 196–260. *Fig. 1–144.*

ROONWAL, MITHAN LAL. 1936. The growth-changes and structure of the egg of the African migratory locust, *Locusta migratoria migratorioides* R. and F. (Orthoptera, Acrididae). Bull. Entom. Res. **27**: 1–14.

ROONWAL, M. L. 1946. On variation in the number of ovarioles and its probable origin in the desert locust, *Schistocerca gregaria* (Forskål). (Orthoptera, Acrididae). Records Indian Mus. **44** (4): 375–384.

RUBTZOV, I. A. 1934. Fertility and climatic adaptations in Siberian grasshoppers. Bull. Entom. Res. **25**: 339–348.

UICHANCO, LEOPOLDO B. 1936. Secular trends of locust outbreaks in the Philippines and their apparent relation with sunspot cycles. Philippine Agriculturist **25**: 321–356.

UICHANCO, LEOPOLDO B., AND ROMULO B. GINES. 1937. A biometrical study of the adult components of Philippine locust swarms. Philippine Agriculturist **26**: 237–289.

UVAROV, B. P. 1928. Locusts and grasshoppers. xiii + 352 p. Frontispiece. *Pl. 1–9.* illus. London: The Imperial Bureau of Entomology.

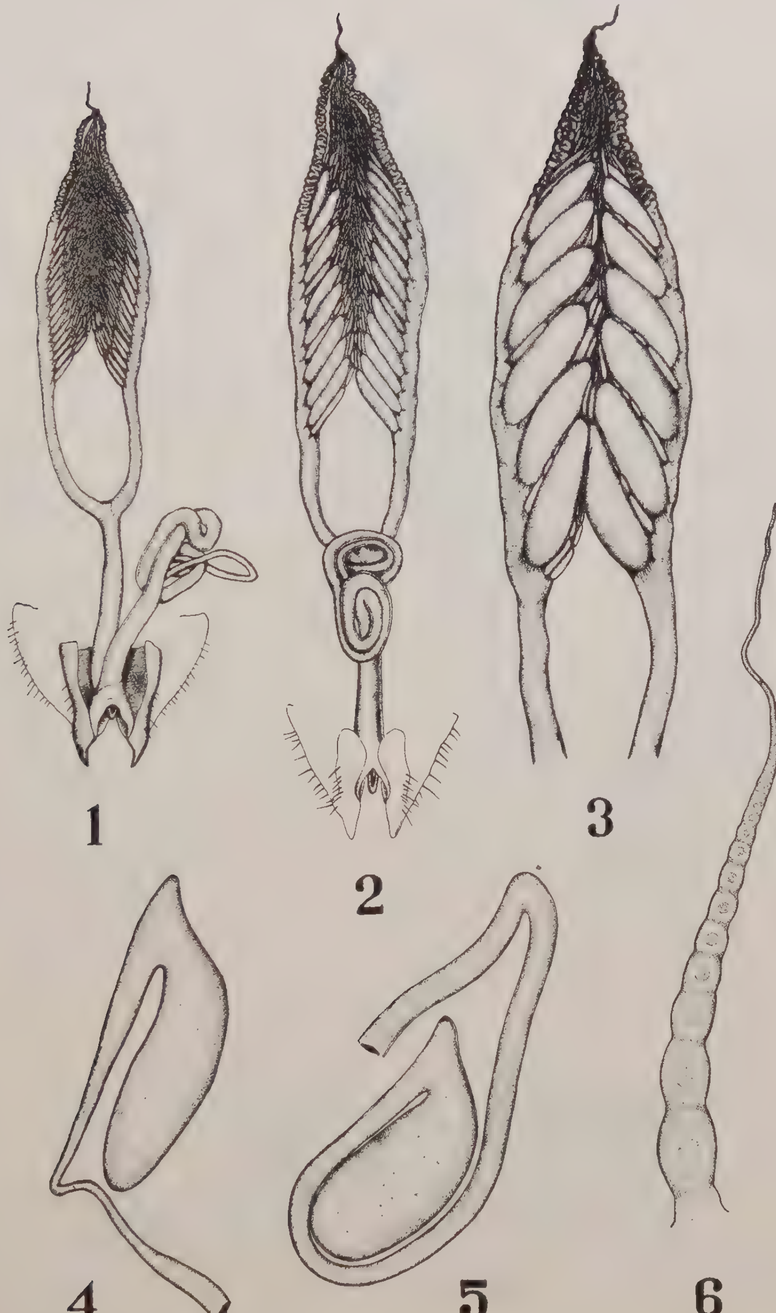
DESCRIPTION OF ILLUSTRATIONS

PLATE 1

Fig. 1. Reproductive system in 7-day female. (Spermatheca pushed aside to show vagina). × 7.
Fig. 2. Reproductive system *in situ* in 14-day female. × 7.
Fig. 3. Ovaries in 34-day female. × 20.
Fig. 4. Spermathecal pouch, KOH-treated. × 30.
Fig. 5. Spermathecal pouch, not macerated. × 30.
Fig. 6. An ovariole from a 3-day fifth-instar hopper. × 50.

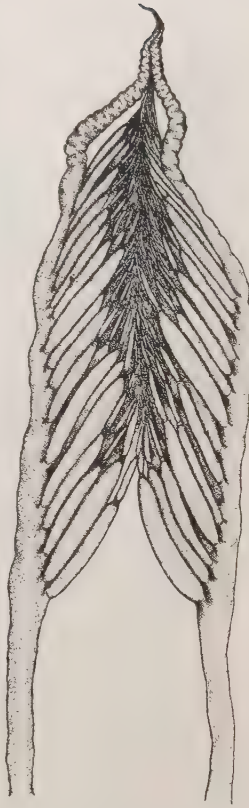
PLATE 2

Fig. 7. Ovarioles from an 86-day female which had laid 5 pods with a total of 208 eggs. × 30.
Fig. 8. Ovaries from which ovarioles in fig. 7 were taken. × 20.
Fig. 9. Ovarioles from a 38-day female. × 30.
Fig. 10. Relative positions of reproductive organs and alimentary tract in female. Semi-schematic. × 5.



VIADO: ORIENTAL MIGRATORY LOCUST

7



8

9

10

VIADO: ORIENTAL MIGRATORY LOCUST

TABLE 1

Summary table of the number of ovarioles in the right and left ovaries

	NUMBER OF INDIVIDUALS		FIDUCIAL LIMITS (COMPUTED RANGE)
Lot 1			
Adult			
Right ovary			
Maximum		52	
Minimum		25	
Average	1,210	32.89 ∓ 0.08	32.7—33.1
Left ovary			
Maximum		50	
Minimum		22	
Average	1,210	32.89 ∓ 0.08	32.7—33.1
Lot 2			
Adult			
Right ovary			
Maximum		54	
Minimum		30	
Average	106	39.8 ∓ 0.42	38.5—41.1
Left ovary			
Maximum		55	
Minimum		28	
Average	106	39.4 ∓ 0.46	38.0—40.8
Fifth-instar hopper			
Right ovary			
Maximum		54	
Minimum		37	
Average	52	44.3 ∓ 0.56	42.6—46.0
Left ovary			
Maximum		56	
Minimum		38	
Average	52	44.2 ∓ 0.59	42.4—46.0

TABLE 2

Summary table comparing the average number of ovarioles in the right and left ovaries of adults and hoppers

	MEAN	D	SD	T	REMARKS
Right ovary					
Lot 1 adults	32.9				
Lot 2 adults	39.8	6.9	0.29	24.14	Highly significant
Lot 2 adults	39.8				
Lot 2 hoppers	44.3	4.5	0.72	6.23	Highly significant
Left ovary					
Lot 1 adults	32.9				
Lot 2 adults	39.4	6.5	0.28	22.74	Highly significant
Lot 2 adults	39.4				
Lot 2 hoppers	44.2	4.8	0.75	6.39	Highly significant

TABLE 3

Summary table of measurements in millimeters of the oldest and next oldest ova of each ovariole at the time of examination

AGE OF ADULTS EXAMINED	NUMBER OF INDIVIDUALS	OLDEST OVUM				SECOND OVUM			
		Length		Width		Length		Width	
			Fiducial Limits (Computed Range)		Fiducial Limits (Computed Range)		Fiducial Limits (Computed Range)		Fiducial Limits (Computed Range)
Less than 24 hours									
Maximum.		0.73		0.28		0.57		0.24	
Minimum.		0.41		0.24		0.41		0.20	
Average...	52	0.58∓0.01	0.55—0.61	0.25∓0.00	0.25	0.44∓0.01	0.41—0.47	0.24∓0.00	0.24
One week									
Maximum.		1.30		0.32		0.81		0.24	
Minimum.		0.89		0.20		0.65		0.20	
Average...	50	1.15∓0.01	1.12—1.18	0.26∓0.01	0.23—0.29	0.73∓0.01	0.70—0.76	0.24∓0.00	0.24
Two weeks									
Maximum.		2.76		0.49		1.30		0.24	
Minimum.		2.03		0.32		0.81		0.20	
Average...	50	2.43∓0.03	2.34—2.52	0.45∓0.01	0.42—0.48	0.91∓0.01	0.88—0.94	0.24∓0.01	0.20—0.26
Three weeks									
Maximum.		6.09		1.30		1.54		0.32	
Minimum.		5.68		1.14		0.89		0.20	
Average...	44	5.88∓0.02	5.82—5.94	1.20∓0.01	1.17—1.23	1.25∓0.02	1.19—1.31	0.27∓0.01	0.24—0.30
Four weeks									
Maximum.		6.82		1.54		1.79		0.41	
Minimum.		6.09		1.14		1.46		0.32	
Average...	43	6.44∓0.03	6.35—6.53	1.37∓0.01	1.34—1.40	1.63∓0.02	1.57—1.69	0.34∓0.01	0.31—0.37

TABLE 4

Summary table of the total number of observed copulations, eggs to a pod, egg-pods, and eggs laid

	NUMBER OF INDIVIDUALS		FIDUCIAL LIMITS (COMPUTED RANGE)
Copulations			
Maximum		19	
Minimum		1	
Average	51	6.5∓0.47	5.1—7.9
Eggs to a pod			
Maximum		65	
Minimum		3	
Average	355	39.4∓0.10	39.1—39.7
Egg-pods			
Maximum		13	
Minimum		2	
Average	51	6.1∓0.39	4.9—7.2
Eggs			
Maximum		489	
Minimum		56	
Average	51	241.2∓18.05	186.1—295.3

TABLE 5

Summary table of measurements in millimeters of oviposition holes, egg-pods, and eggs

	NUMBER OF INDIVIDUALS		FIDUCIAL LIMITS (COMPUTED RANGE)
Depth of oviposition holes			
Maximum		85	
Minimum		42	
Average	307	67.2∓0.42	65.9—68.5
Egg-pods			
Length			
Maximum		38.5	
Minimum		10.0	
Average	334	25.5∓0.28	24.6—26.3
Width			
Maximum		7.0	
Minimum		3.5	
Average	334	5.4∓0.03	5.3— 5.5
Eggs			
Length			
Maximum		6.7	
Minimum		5.1	
Average	324	6.1∓0.02	6.0— 6.2
Width			
Maximum		1.7	
Minimum		1.1	
Average	324	1.3∓0.00	1.3

TABLE 6

Summary table of the developmental periods of the migratory locust

PERIOD OF DEVELOPMENT	NUMBER OF INDIVIDUALS		FIDUCIAL LIMITS (COMPUTED RANGE)
		days	*days*
Incubation period			
Maximum		18	
Minimum		16	
Average	29[a]	17.0∓0.19	16.4—17.6
First stadium			
Maximum		15	
Minimum		5	
Average	169	8.2∓0.12	7.8—8.6
Second stadium			
Maximum		14	
Minimum		4	
Average	165	7.6∓0.14	7.2—8.0
Third stadium			
Maximum		11	
Minimum		4	
Average	159	6.4∓0.11	6.3—6.7
Fourth stadium			
Maximum		9	
Minimum		5	
Average	152	6.3∓0.08	6.1—6.6
Fifth stadium			
Maximum		12	
Minimum		7	
Average	141	8.6∓0.09	8.3—8.9
Emergence to first oviposition			
Maximum		41	
Minimum		10	
Average	51	20.0∓0.10	19.7—20.3
Period of fecundity			
Maximum		80	
Minimum		9	
Average	51	32.9∓2.02	26.8—39.0
Longevity of female			
Maximum		92	
Minimum		26	
Average	51	52.7∓2.07	46.5—58.9

a Egg-pods

VANILLA CULTURE IN THE COLLEGE OF AGRICULTURE AT LOS BAÑOS[1]

PEDRO A. DAVID
Of the Department of Agronomy

WITH FOUR TEXT FIGURES

The Philippines imports cured vanilla pods and extracts for flavoring foods and for perfumery. Under favorable soil and climatic conditions, vanilla can be grown in many parts of the Philippines. According to Mr. Henry A. Bellis, production manager, Philippine American Drug Co., Manila, the cured vanilla pods produced in the College of Agriculture are very much better than those imported from Tahiti, and they compare very favorably with the true Mexican vanilla, which is considered the best in commerce.

The Philippine annual importation of cured vanilla pods and extracts shows the present large demand for it. When the demand, the suitability of many localities of the Philippines for its culture, and the production of good vanilla pods are considered, the prospects of vanilla as a new crop are very encouraging.

In answer to the requests received by the Department of Agronomy of this College for information regarding vanilla culture, the present paper was prepared.

VARIETIES

At present there are only a few species of vanilla under cultivation in other countries. The most important species is *Vanilla planifolia* Andr. (*V. fragrans* [Salisb.] Ames), which is considered the best in commerce. This species is the true Mexican vanilla which is cultivated chiefly in Mexico and, to some extent, in the East and West Indies, Madagascar, and other tropical regions. The true Mexican vanilla produces long, slender, green pods, which give excellent quality and aroma when properly cured.

The vanilla plant introduced and cultivated in the College is *Vanilla planifolia* (fig. 1). It is a perennial, epiphytic climbing vine of the orchid family (Orchidaceae). The plant produces long, flexuous, succulent green stems which attach themselves to the trunks and branches of trees or supports by means of aerial roots produced on the stem opposite the leaves. The leaves are ovate, almost sessile, fleshy, and bright green. The plant bears pale yellow flowers on pedicels. The pod-like fruits vary in length from 7 to 22 centimeters and contain an enormous number of minute black seeds (fig. 2).

Of the other species, *Vanilla tahitensis* Moore is grown mostly in Tahiti and Hawaii. It produces cured pods with an aroma distinctly inferior to that of *V. planifolia*. *Vanilla pomposa* Schiede is known as West Indian vanilla. It produces short, thick, and fleshy pods which are not highly va-

[1]Experiment Station Contribution No. 1548.

lued. As the cured pods of this species command a lower price than the first two, its cultivation in most places has been abandoned. *Vanilla fragrans* (Salisb.) Ames is grown in the Federal Experiment Station of the United States Department of Agriculture in Puerto Rico.

Fig. 1.—Upper panel, young vanilla plants on *Gliricidia sepium* (Jacq.) Steud., planted 3 × 3 meters apart. Lower panel, a 10-year-old vanilla plantation with *Gliricidia sepium* (Jacq.) Steud. as supports in the College of Agriculture.

SOIL

Vanilla is a forest-grown plant. It requires a light and friable soil rich with well-rotted vegetable matter, and under partial shade. In this

College, vanilla is grown on a deep, loose, well-drained, dark-colored vegetable loam near the bank of the Molawin creek. The vanilla plants tried on stiff and poorly drained clay soils were total failures.

Fig. 2.—Left panel, *Vanilla planifolia* Andr. (*V. fragrans* [Salisb.] Ames) showing its long, strong, aerial roots opposite the nearly sessile, oblong, acute leaves; and its mature pods. Note the overmature pod which splits open at its lower end. Right panel, mature pod cut open lengthwise showing its minute seeds which are sandy to the touch.

CLIMATE

The vanilla plant thrives well in the hot, humid climate of the College, about 35 meters above sea level. The plants are grown on living supports in a light-shaded place, free from strong winds. Those planted in exposed places suffer from the long dry season and from strong typhoons.

PROPAGATION

Vanilla is easily propagated by cuttings. Its minute black seeds (fig. 2) contained in the pods require a special technique to grow. They are not used for commercial planting. Mexican vanilla planters believe that plants grown from long cuttings, about a meter long (3 to 4 feet), flower earlier than those from short cuttings, about a foot long.

In the College, cuttings one meter or more long are prepared from any part of healthy vines during the rainy months of the year. The leaves and old aerial roots from the first three or four basal nodes are cut off. The prepared cuttings are planted at the foot of their supports (fig. 1). Cuttings for shipment to distant places are carefully packed in folded banana or abacá leaf sheaths, where they root in twenty days if kept in the shade.

PREPARATION OF THE LAND

A small clearing of a second-growth forest is made by cutting down unnecessary trees during the summer months and leaving only good leguminous trees to furnish partial shade and supports for the vanilla vines. All felled trees and branches are chopped into small pieces and allowed to decay on the spot. Some of the large trees may be pruned, and additional trees may be planted to supplement the needed supports for the vanilla plants.

LIVING TREES TESTED AS SUPPORTS

The trees which have been tested for supports of vanilla in the College are as follows:

COMMON AND SCIENTIFIC NAMES	FAMILY
1. Calachuchi, *Plumiera acutifolia* Poir	Apocynaceae
2. African tulip tree, *Spathodea campanulata* Beauv	Bignoniaceae
3. Kapok, *Ceiba pentandra* (L.) Gaertn	Bombacaceae
4. Anonang, *Cordia dichotoma* Forst. f	Boraginaceae
5. Pili, *Canarium luzonicum* (Blume) A. Gray	Burseraceae
6. Physic nut, *Jatropha curcas* Linn	Euphorbiaceae
7. Baguilumbang, *Aleurites trisperma* Blanco	Euphorbiaceae
8. Para rubber, *Hevea brasiliensis* (HBK) Muell.-Arg	Euphorbiaceae
9. Palomaria, *Calophyllum inophyllum* Linn	Guttiferae
10. Kalingad, *Cinnamomum mercadoi* Vidal	Lauraceae
11. Madre cacao, *Gliricidia sepium* (Jacq.) Steud	Leguminosae
12. Ipil-ipil, *Leucaena glauca* (L.) Benth	Leguminosae
13. Dapdap, *Erythrina variegata* L. var. *orientalis* (L.) Merr	Leguminosae
14. Divi-divi, *Caesalpinia coriaria* Willd	Leguminosae
15. Strychnine, *Strychnos nuxvomica* Linn	Loganiaceae
16. African Oil Palm, *Elaeis guineensis* Jacq	Palmae
17. Cacao, *Theobroma cacao* Linn	Sterculiaceae

For live supports for vanilla in the College those of the family Leguminosae were found best. The trees are easily propagated by cuttings; they grow rapidly, branch regularly, and are sufficiently strong to carry the vanilla plant. The other trees tested were either slow growers, too weak to support the vanilla vine, or too shady. The African Oil Palm has proved to be a good support because of the decayed vegetable matter which accumulates on the bases of the leaves, but it is a slow grower and is readily attacked by *Oryctes rhinoceros* Linn. and by the fungus *Phytophthora palmivora* Butler.

Vanilla planters should select carefully the trees to use as live supports. Trees suitable for support in one locality or province may not be adapted in another of different soil and climatic conditions.

PLANTING

The supports vanilla plants need to cling to may be either young trees or stakes of strong cuttings of quick-growing trees. For this purpose, stems of *Gliricidia sepium* (Jacq.) Steud., about 1.5 meters long and 10 centime-

ters in diameter, are cut and driven into the soil, 30 centimeters deep and 3 by 3 meters apart during the rainy season. *Gliricidia* stems are used because they grow quite fast and are strong enough to support the weight of the vanilla vine. When the supports are ready, the vanilla cuttings are planted.

In planting, the clean lower portion of the vanilla cutting is inserted into the soil, close to its support. Then the cutting is carefully covered with well-pulverized rich humus and well-decayed leaves. The soil around each support is heaped up to prevent water-logging. The free upper part of the cutting is entwined round its support and tied to it with abaca or banana leaf-sheath ribbons. Wire or hard twines should be avoided because they will cut into the succulent stem of the vanilla plant. The plantings are watered as needed during dry weather until they have produced aerial roots and attached themselves to their supports. Plantings on January 12, 1949, were well established on May 15, 1949 (fig. 1, upper panel).

CULTIVATION

The ground around each vanilla plant is weeded and mulched with composted leaves, grasses, or whatever other vegetable matter available in the field. The mulch is heaped up around the plant. The soil is also heaped slightly to avoid accumulation of water during the rainy season. The vanilla plant derives a large portion of its nutrient requirements from the mulch around its base. The long aerial roots on the supports elongate further until they reach the ground and then branch out at their tips. All mulched plants in our experimental fields showed profuse vegetative growth. Mulching vanilla plants is called for especially during the dry hot months. Clean weeding is not necessary, although the tall weeds should be cut down.

After attaining a sufficient length, the shoots are trained to follow the branches of their supports, so that they climb over and hang down. In about one and one-half years, the plants are pruned. Pruning induces them to produce flowers on the overhanging lower branches to within 30 centimeters from the ground.

DISEASES AND PESTS

An important fungus disease caused by *Calospora vanillae* has been reported as attacking the pods, leaves, and stems of the vanilla plant, as well as of other orchids grown in flat, damp, and poorly drained land in Seychelles, Mauritius, Réunion, Tahiti, and elsewhere. *Colletotrichum vanillae* has also been reported on vanilla foliage and *Fusarium batatatis* var. *vanillae* on vanilla roots. These diseases, however, have not been observed on vanilla cultures of the College.

The insect pests which have been reported in other countries on the vanilla plant are: *Trioza litseae*, *Nezara smaragdula*, *Conchylia vanillana*, *Plusia aurifera*, *Simplica inarcualis*, *Cratopus punctum*, *Perissoderes ruficollis*, large and small snails, and a slug. In the College vanilla plantation only a bug, *Nezara viridula* Linn. (Pentatomidae, Hemiptera) and a moth caterpillar, *Plusia chalcytes* Fabricius (Noctuidae, Lepidoptera), which are both polyphagous species, were observed. However, these were not destructive. A weevil, *Araeocerus fasciculatus* DeGeer (Anthribidae), was found on cured vanilla pods, although it did not appreciably damage the pods.

The giant African snail (*Achatina fulica*) was found on vanilla plants and their supporting *Gliricidia sepium.* The snail did not appear to be destructive on vanilla.

POLLINATION

The flowering season of the vanilla plants in the College begins as early as March and lasts till June.

Natural fertilization seldom occurs because of the peculiar arrangement of the flower structure. The anther and pollen masses are covered by a cup called "hood" and the stigma is hidden by a lip, "lamellum," or "rostellum," which prevents self-pollination. In order to insure and regulate the production of vanilla pods, it is necessary to hand-pollinate the flowers.

In the College vanillery, hand-pollination is done at 8 to 10 o'clock in the morning when the flowers open and the stigma is receptive. The lip which covers the stigma is pushed back with a toothpick or bamboo splinter and the pollen masses placed on the stigma. With this method, the pollen of a flower is used for pollinating its own stigma. Although cross fertilization may give better results, more time is required in transferring the pollen from one flower to the stigma of another.

After a little training and practice laborers can perform the work of hand-pollinating successfully. A successfully pollinated vanilla flower withers, but it persists on the pod until the latter is nearly ripe. If the flower and its petals fall off, fertilization has not taken place. One laborer can pollinate from 150 to 200 flowers in two hours, depending on the availability of the flowers within his reach on the vines; otherwise, a ladder is necessary to enable him to reach the flowers. A good vanilla plant in the College culture produces about 100 racemes. One raceme has 10 to 20 flowers, of which only five should be fertilized if long pods (fig. 2) are to be produced. One good healthy vine may be allowed to produce about 100 pods, but a weak one only 50 pods. Vigorous vanilla plants in the College cultures produce an average of 118 pods on 23 racemes. It has been observed that over-cropped plants die soon. Their roots, stems and leaves dry, and the whole vine dies.

The number of vanilla flowers pollinated by one agronomy laborer on 74 experimental plants from 8 to 10 a.m. and the months during which fertilization was carried on follow:

MONTH AND YEAR	NUMBER OF DAYS OF ACTUAL POLLINATION	TOTAL NUMBER OF POLLINATED FLOWERS
March, 1946	5	110
April	13	1,199
May	19	1,183
June	4	30
April, 1947	16	6,798
May	5	224
March, 1948	13	4,003
April	17	1,944
March, 1949	1	37
April	25	3,141
May	6	158

In the College, from April to May is the height of the flowering season. A total of 18,827 flowers were pollinated in 124 days, at two hours a day, or 75 flowers an hour. In 1946 and 1947, pollination was done on

old plants (fig. 1 lower panel). The pollinator used a ladder to reach the flowers. In the following years, only five flowers in each raceme were fertilized so as to produce long pods (fig. 2).

HARVESTING

In the College, flowers pollinated during March, April, May, and June were ready for harvesting nine months later. The principal crops were harvested in December and January. Only pods at the right stage of maturity should be picked out singly from the racemes. The indications of ripening of vanilla pods are: change of color from dark green to a light green, loss of luster of the pods, development of the lines of dehiscence, and slight yellowing at the lower or thickest ends of the pods. The last is the most reliable guide to proper maturity. If a pod splits open at its lower end (fig. 2, right panel), it is overmature. An overmature pod, when cured, gives an undesirable texture and poor aroma. On the other hand, if immature when cured, the pods become hard, are easily attacked by white molds, become discolored, and produce little or no vanilla flavor. An almost uniform color of cured vanilla pods results when uniformly mature pods are harvested. If a commercial product of good quality is desired, it is necessary to go through the vanillery every three or four days during the harvesting season.

Collection of properly matured pods from every vine should be done at regular intervals. When bent to one side, mature vanilla pods will snap off from the raceme. The harvested pods should be carefully handled in the field, as any injury will be a permanent damage to the finished product. All harvested pods are placed in a basket and brought to the curing room or shed.

The classification of length of the pods harvested during the crop years 1948, 1949, and 1950 was done as follows:

CLASS LIMITS	NUMBER OF PODS MEASURED		
	(1948)	(1949)	(1950)
cm.	*f*	*f*	*f*
5.0– 6.9	0	1	0
7.0– 8.9	42	11	2
9.0–10.9	133	69	78
11.0–12.9	289	183	208
13.0–14.9	423	283	345
15.0–16.9	341	235	357
17.0–18.9	115	168	184
19.0–20.9	13	53	21
21.0–22.9	0	9	0
Total number of pods (*f*)	1,356	1,012	1,195
Mean length in cm.	$13.85 \mp .07$	$14.75 \mp .08$	$14.65 \mp .07$
Standard deviation	$2.48 \mp .05$	$2.76 \mp .06$	$2.36 \mp .05$
Coefficient of variability, per cent	$17.90 \mp .34$	$18.71 \mp .41$	$16.11 \mp .32$

CURING

The vanilla pods should be properly cured to produce their characteristic aroma. In the College, vanilla pods are cured in the following manner:

Wilting the pods with boiling water. The pods are first sorted according to size and degree of maturity. All pods split at their blossom ends are tied. The pods are then tied into bundles of 20 or 30 and dipped in boiling

water for 10 to 20 seconds. The bundles are then untied, the pods placed on a bamboo sieve to drain dry, and finally spread out in an open tray or "bilao" covered with woolen blankets (fig. 3, upper panel). The pods on the tray are exposed to the sun or to infra-red light at 40° to 45°C. during cloudy days, for a short period. Sun drying may take seven to ten days, depending on the intensity of the light.

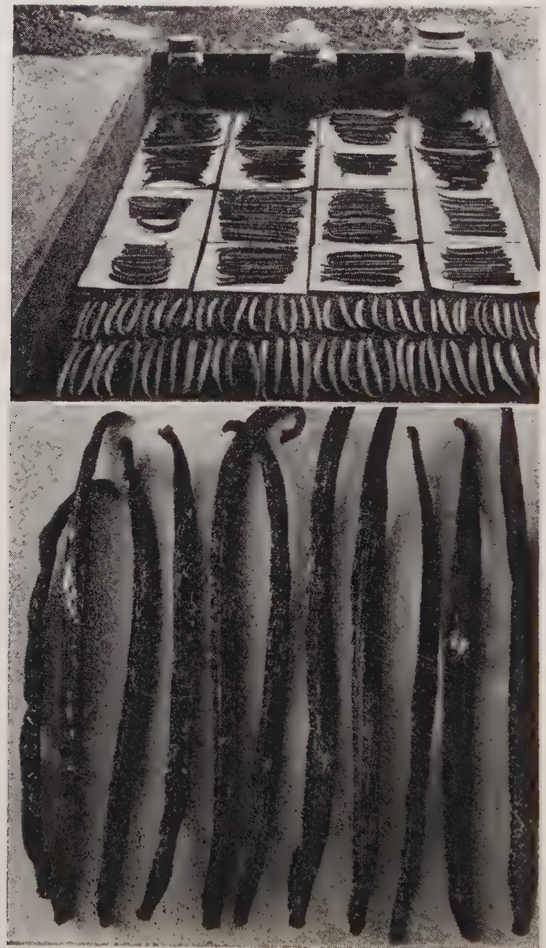


Fig. 3.—Upper panel, vanilla pods being dried in an open tray covered with white paper and woolen cloth. Lower panel, vanilla cured pods with vanillin crystals after seven months of conditioning in airtight preserving jars.

Sweating the pods by slow drying. In the afternoon, the pods are rolled up in the woolen blankets, placed in an airtight container or wooden box until the following day, when they are spread in the morning and exposed to the sun again for a short time. This slow and gradual process of sweating

is continued for several weeks until the pods become brown and pliable. During the sweating process the pods are squeezed lightly between the fingers one by one so as to straighten them and distribute equally the seeds and oily substance inside the pods. All pods that have become flexible and with uniform deep chocolate brown color are separated for final drying.

Drying the pods slowly at room temperature. The pods are arranged side by side in a basket, covered with cloth, and placed in a well-ventilated room. This process of slow drying is continued for several weeks during which time the pods are turned over once in a while for uniform drying. When the moisture content of the pods is reduced to approximately 30 to 35 per cent, they are ready for the conditioning process.

Conditioning the pods in boxes or glass jars. The dried pods are put in airtight jars or boxes to avoid excessive drying (fig. 3, upper panel). The jars are examined every day. Molds usually appear on pods which contain a high percentage of moisture. Moldy pods become wrinkled and dry. All pods which become moldy are removed from the lot and wiped with cotton wet with 95 per cent ethyl alcohol. Absolute cleanliness is necessary in conditioning vanilla pods. Some pods conditioned in preserving jars developed vanillin crystals after a few months (fig. 3, lower panel and fig. 4, left panel).

CLASSIFICATION

The cured vanilla pods are first sorted for quality and then according to their lengths before they are finally packed for the market. All pods produced in the College are classified as follows:

CLASS	APPEARANCE OF THE PODS	AROMA	TEXTURE	COLOR
First.........	Oily, thick, without splits or blemishes	Strong	Very pliant	Dark chocolate or black
Second........	Over-dried	Medium	Rough	Reddish
Third.........	With splits	Fair	Hard	Brownish
Fourth........	Spotted, splits, and broken	Poor	Corny	Brownish

Each class is again classified according to length. Pods are designated as extra long when they exceed 20 cm.; long, when they are 15 to 20 cm.; normal when they are 10 to 15 cm.; and short, when they are 5 to 10 cm. long.

BUNDLING

After the pods have been sorted into classes and lengths, they are tied in bundles (fig. 4, right panel) of fifty pods each. The flower ends of the pods are placed even so that the bundle can stand on these ends after tying with clean string (fig. 4, right panel). The stem ends are folded in so that both ends are even (figure 4, right panel). The bundles are then finally packed in airtight bottles or preserving jars. Wrapping the bundled pods separately in paraffined or oiled paper is recommended before they are packed for shipment to prevent the spread of molds from one packet to the other.

ESTIMATED YIELD

The 74 vanilla plants in the experimental cultures produced 2,368 cured pods during the crop years 1948 and 1949. Each plant gave an aver-

age yield of 16 pods a year. One thousand fresh pods, when cured, weighed 3.215 kilograms.

If each plant produces an average of 16 cured pods a year, two plants or vines to a support, 1,111 supports at 3 by 3 meters to a hectare, and 1,000 fresh pods weigh 3.215 kilograms when cured, a hectare will produce 35,552 pods with a total cured weight of 114.30 kilograms. One-half of

Fig. 4.—Left, vanilla cured pods in an airtight preserving jar showing vanillin crystals after some months of conditioning. Right, cured vanilla pods sorted into lengths and bundled. Two types of bundling commercial vanilla pods for shipment.

this may be of superior quality, valued at ₱35.00 a kilogram, based on Manila price; and with the other half valued at ₱17.00 a kilogram, a total return of ₱2,971.80 a hectare would be realized.

In 1948, the Philippine American Drug Co. bought from the Department of Agronomy, College of Agriculture, 15.144 pounds of mixed cured vanilla pods for ₱242.21, or ₱35.21 a kilogram. Based on this sale of the College cured vanilla pods, a total yield of 114.30 kilograms of mixed cured pods will give a return of ₱4,024.50 a hectare.

SUMMARY

1. Trial plantings of *Vanilla planifolia* Andr. (*V. fragrans* [Salisb.] Ames) were made in the College of Agriculture Experiment Station at Los Baños, Philippines. The plants thrive well in the rich soil, in the hot and humid climate of Los Baños, under partial shade and protected from strong winds by the leguminous supports, *Gliricidia sepium*.

2. For commercial planting, long cuttings prepared from any part of the vine were used.

3. The main flowering season of vanilla in Los Baños is from April to May.

4. Hand-pollination is necessary for the production of vanilla pods. It takes the pods about nine months to mature after pollination.

5. In order to obtain a commercial product of good quality, it is necessary to harvest only properly mature pods as indicated by the yellowing of their blossom ends.

6. The vanilla pods should be properly cured to produce their characteristic aroma. Curing is done by dipping the harvested pods in boiling water to kill the tissues and to prevent splitting of the pods, then sweating and later drying them slowly either in the sun or with artificial heat.

7. Properly cured vanilla pods produce vanillin crystals on their surface.

8. Special attention should be given to details of cultivation, propagation, pollination, curing and grading of cured pods for the production of marketable vanilla pods.

A COMPARATIVE STUDY OF TWO RATIONS FOR GROWING CHICKS[1]

Francisco T. Ramos
Of the Department of Agricultural Economics

It is a common practice both in the Philippines and elsewhere to feed poultry, especially pullets and mature birds, with mash supplemented with an equal amount of scratch grain. In the United States, scratch grain, whether fed in separate hoppers or scattered over the litter, is usually given when the chicks are four to six weeks old, and the amount is varied according to the age of the chicks. The grain is gradually increased as the birds grow older. In the Philippines, however, if the chicks are given mash feed, they are seldom given scratch grain. If ever they are given scratch grain, its proportion to the mash is not definite and the age of the birds is not a factor in determining its proportion with the mash.

This study was conducted in the Department of Animal Husbandry from August, 1948, to January, 1949, to determine the influence of the addition of grain to the all-mash ration on growing chicks and ultimately find out if the College all-mash chick ration may be improved.

Briggs and Jull (1946) recommended the giving of supplementary grain of 5, 10, 20, and 30 per cent of the total feed during the ages of six, eight, ten, and twelve weeks, respectively. Almquist, Jukes, and Newlon (1943) suggested a grain-feeding schedule in the proportion, by weight, of 1 part grain to 4 parts mash at five and six weeks of age, 2 parts grain to 5 parts mash at seven to eight weeks, 1.3 parts grain to 2 parts mash at nine to ten weeks, and 9 parts grain to 10 parts mash at twelve weeks. Sison (1928)[2] reported that normally fed chicks receiving grain and mash grew faster and were more vigorous than those receiving mash only. He further found that the chicks given the normal feeds consumed a little more than the all-mash-fed chicks.

MATERIALS AND METHODS

In this study, a total of 300 one-day-old New Hampshire chicks were used. Three trials were conducted, each covering a period of twelve weeks. Each trial consisted of two lots of 50 chicks each. Thus, there were in all 150 chicks to each lot. The chicks were wingbanded and weighed to get their initial weights and their weekly weights thereafter until the end of the observation period of twelve weeks.

---

[1]Experiment Station Contribution No. 1549. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1949. Prepared in the Department of Animal Husbandry under the direction of Professor F. M. Fronda.

[2]Sison, Sixto. 1928. The all-mash method of feeding chickens. (Thesis presented for graduation from the College of Agriculture. 1928. Unpublished.) *Cited by* Amon, Valentin G. 1930. Studies on the influence of free choice of feed in poultry feeding. The Philippine Agriculturist **19**: 445–459.

To the control lot (lot I) the College all-mash chick ration composed of the following ingredients, all parts by weight, was given throughout the entire brooding period of twelve weeks.

Rice bran	55
Ground corn	20
Fish meal	20
Copra meal	5

In lot II the same ration was given during the first four weeks. From the fifth week to the twelfth week, coarsely ground corn as grain was added and mixed with the mash in the proportion of 1 part grain to every 2 parts, by weight, of the mash mixture. Two parts of common table salt was added to every 100 parts mash in both lots. The mash was given dry in sufficient amounts twice a day, morning and afternoon.

The chicks were first raised in separate identical pens with concrete flooring and rice hulls as litter. The brooding compartments of the pens were not artificially heated. Chopped green grass was supplied to them daily, and they were also allowed free access to ground shell and grit. After the first four weeks, the chicks were moved from the pens to the battery brooders and raised there until they were twelve weeks old. Except for the difference in feed, the two lots were given identical management and care.

The initial and weekly weights of the individual birds, the weekly feed consumption, and mortality were recorded.

DISCUSSION OF RESULTS

Rate of growth. The average biweekly weights of the New Hampshire chicks in both lots given in table 1 show that there was a slight difference of 0.5 gram between lot I and lot II in the initial weights of the chicks. This difference, however, was found to be statistically insignificant and, therefore, should not be considered an advantage of one lot over the other. Moreover, the initial chick weight, according to Asmundson and Lerner (1942), has no influence on the rate of growth of the chicks up from eight to twenty weeks of age, provided the chicks were hatched under normal conditions.

It may be interesting to note that at the age of two weeks the chicks in both lots more than doubled their respective initial weights, and that at the end of the fourth week those initial weights were almost quadrupled. Throughout the twelve-week period of the experiment, lot I was consistently heavier than lot II, although these differences in weights were not big enough to be statistically significant. In the third and fourth weeks, however, lot I was significantly heavier than lot II. It should be noted that these significant differences were made when both lots were still receiving the same feed. These differences may be due to some inherent growth factors of the birds in lot I. Asmundson and Lerner (1933), in a study of six families of Single Comb White Leghorns from the same flock raised together under the same management, found a demonstration of inherent growth-rate differences that were significant from the ages of two to eight weeks.

At the twelfth week the average weight of the chicks in lot I was 803.7 grams, and that of lot II, the grain-and-mash lot, 755.3 grams. The difference in weight at this age, however, was insignificant. On the basis of weight gained from the first day to the twelfth week, the all-mash-ration lot was only 6.25 per cent more efficient than the grain-and-mash lot. The mean weight of the twelve-week-old New Hampshire chicks obtained in this study was higher than that reported by Mondoñedo (1948)[4] for the same breed, which was only 604.0 grams.

The greatest gain in both lots was obtained when the chicks were nine to twelve weeks old. The chicks gained more than half of their final weights within these last four weeks. This result confirms the report of Kempster (1941) and of Mondoñedo (1948)[3] that the heaviest gains were made at the age of nine to twelve weeks.

The biweekly growth rates of the birds expressed in per cent are shown in table 2. The following formula, as advanced by Asmundson and Lerner (1942), was used in the computation of rate of growth:

$$R = \frac{W_2 - W_1}{\frac{1}{2}(W_2 + W_1)} \times 100$$

where W_2 is the weight at the end, and W_1 the weight at the beginning of the period considered. Table 2 shows that the weekly growth rates of the chicks had the general tendency to decrease gradually as the chicks grew older. This tendency, however, was not consistent in all three trials. The inconsistency was perhaps due to the influence of bad weather and diseases and to seasonal variations. The average growth rate of lot I was 182.17 per cent for the entire brooding period of twelve weeks, while that of lot II was 181.32 per cent.

It is commonly known among poultrymen that in a breed the males grow faster and heavier than the females. When the males were taken separately from the females, it was found that at the age of twelve weeks the males were much heavier. In lot I the males had an average final weight of 963.1 grams, while the females had an average of only 729.1 grams. In lot II the males weighed 930.1 grams, on the average, while the females weighed only 699.2 grams. The percentage of growth rate between the males and the females in either of the lots showed no appreciable difference. The difference in the average final weights of the males in lot I and in lot II was insignificant. The same was true between the females.

Feed consumption and feed cost. Table 3 shows the amount of feed consumed by the birds in each lot, computed on the basis of 100 chicks raised to the weaning age of twelve weeks. It may be noted that lot I consumed slightly more feed than lot II—a difference of only 5.80 kilograms. The cost of the feed consumed by the chicks in lot II was, however, higher than that consumed by the chicks in lot I. The high price of corn grain made the grain-and-mash ration of lot II more expensive than the all-mash ration of lot I. On the average, a kilogram of the all-mash ration cost ₱0.31 while the same quantity of the grain-and-mash ration cost ₱0.33.

---

[3]MONDOÑEDO, JOSÉ R. 1948. A comparative study of the efficiency of producing broilers from the New Hampshire, Los Baños Cantonese, and Single Comb White Leghorn breeds of poultry. (Thesis presented for graduation from the College of Agriculture. 1948. Unpublished.)

To produce a kilogram gain in weight, lot I required 6.03 kilograms of feed which cost ₱1.87, and lot II required 5.85 kilograms which cost ₱1.93. In this regard, lot II was more efficient than lot I by only 2.99 per cent. Although lot I required a little more feed to produce a kilogram gain than did lot II, the cost is lower by ₱0.06 a kilogram in favor of the all-mash lot.

Inasmuch as a poultryman is greatly interested in the income he derives from his flocks, the returns above cost of feed should be the basis in determining the better method or feed combinations to use. As shown in table 3, lot I had greater returns above the cost of feed. Based on 100 chicks raised to twelve weeks of age and on the actual price at which these fowls were sold, which was ₱2.00 a kilogram live weight, the returns above cost of feed for lot I was ₱66.30, while that of lot II, only ₱52.97. In this connection, mention should be made also of the fact that the addition of grain to the mash fed to the young chicks required extra time and work; the corn grain had to be ground coarsely and mixed with the mash.

Mortality. The percentages of mortality of the two lots are shown in table 4. For the twelve-week period, the mortality in lot I was 54.00 per cent and in lot II, 50.67 per cent. This apparently high percentage of mortality in the two lots was due to diseases, such as coccidiosis, roup, and fowl pox. The heaviest mortality occurred during the fourth and fifth weeks of the last two trials when a disease suspected to be coccidiosis broke out in both lots. Remedial measures were taken by using the sulfaguanidine treatment on the entire flock. The incidence of roup and fowl pox as early as the second and third weeks affected adversely the vitality of the birds and resulted in the heavy mortality later.

Quality of weanlings produced. Table 5 shows the quality of chicks at the end of the brooding period of twelve weeks. The birds were classified into 3 grades: A, B, and C, according to their general appearance, vigor, and size. Lot I produced 24 birds, or 34.78 per cent of the superior grade, grade A. Lot II, on the other hand, had only 20 birds of this same grade, which was 27.02 per cent of the flock. Of the intermediate grade, or grade B, lot II had 42 birds, or 56.76 per cent, and lot I only 35, or 50.72 per cent. Under the last grade, or grade C, were the weanlings known as culls. They were either too small for their age or unthrifty in appearance. Lot I had 10 of these birds, or 14.49 per cent; lot II had 12, or 16.21 per cent. Of the living birds, lot I had a slightly higher percentage (85.50) of the superior quality (grades A and B) than lot II (83.78).

SUMMARY

1. Although at the age of twelve weeks the chicks that were fed with the College all-mash chick ration were slightly heavier than the chicks fed the grain-and-mash ration, the difference in weight was statistically insigficant.

2. The chicks fed with the College all-mash chick ration required only a little more feed to produce a kilogram gain than those fed with grain and mash.

3. Although more feed was needed to produce a kilogram gain with the all-mash feed than with the grain-and-mash feed, the former was more economical.

4. The chicks given the all-mash ration suffered a slightly higher mortality than the chicks given the grain-and-mash ration.

5. The lot which used the all-mash ration produced a higher percentage of superior-class birds than the lot which used grain-and-mash ration, although the latter had a higher percentage of average class birds, weanlings not culls, than the former.

6. The feeding of grain with mash may probably be used to advantage in places where corn is abundant and cheap.

LITERATURE CITED

ALMQUIST, H. J., T. H. JUKES, AND W. E. NEWLON. 1943. Feeding chickens. California Agricultural Ext. Serv. Cir. 108:1–32.

ASMUNDSON, V. S., AND I. MICHAEL LERNER. 1942. Breeding chickens for meat production. California Agricultural Exper. Sta. Bull. 675:1–39.

BRIGGS, GEORGE M., AND MORLEY A. JULL. 1946. Feeds and feeding practices for chickens. University of Maryland Ext. Serv. Bull. 109:1–27.

KEMPSTER, H. L. 1941. The normal growth of chickens. Missouri Agric. Exper. Sta. Bull. 423:1–20.

TABLE 1

Average biweekly weights of the New Hampshire chicks

AGE	LOT I All-mash fed	LOT II Grain-and-mash fed
	grams	*grams*
1 day	37.5∓ 0.26	37.0∓ 0.28
2 weeks	80.5∓ 1.12	78.5∓ 0.77
4 weeks	139.4∓ 3.03	130.0∓ 2.99
6 weeks	235.5∓ 6.26	231.5∓ 6.10
8 weeks	369.5∓11.74	359.0∓12.06
10 weeks	566.5∓19.31	517.5∓21.15
12 weeks	803.7∓26.76	755.3∓27.99
Relative efficiency, per cent	100.00	93.75

TABLE 2

Average biweekly gain and rate of growth of the New Hampshire chicks

AGE	LOT I		LOT II	
	Gain in weight	Rate of growth	Gain in weight	Rate of growth
weeks	*grams*	*per cent*	*grams*	*per cent*
0—2	43.0	72.88	41.5	71.86
2—4	58.9	53.57	51.5	49.40
4—6	96.1	51.27	101.5	56.15
6—8	134.0	44.30	127.5	43.18
8—10	197.0	42.09	158.5	36.17
10—12	237.2	34.55	237.8	37.37
0—12	766.2	182.17	718.3	181.32

TABLE 3

Returns above feed cost (based on 100 chicks raised to twelve weeks of age)

ITEMS	LOT I	LOT II
Total amount of feed consumed, kilograms	300.40	294.60
Total cost of feed, pesos	94.46	98.09
Average feed consumption of each bird, kilograms	3.004	2.946
Weanlings produced, kilograms	80.38	75.53
Returns from sale of weanlings, pesos[a]	160.76	151.06
Feed required for each kilogram gain, kilograms	6.027	5.851
Cost of feed required to produce a kilogram gain, pesos	1.87	1.93
Returns above cost of feed, pesos	66.30	52.97

[a]Weanlings were sold at ₱2.00 a kilogram live weight.

TABLE 4

Percentage of mortality

ITEMS	LOT I	LOT II
Number of chicks at the start	150	150
Number of weanlings after twelve weeks	69	74
Number of chicks that died	81	76
Percentage of mortality	54.00	50.67

TABLE 5

Quality of weanlings produced

LOTS	SEX	GRADES A No.	GRADES A per cent	GRADES B No.	GRADES B per cent	GRADES C No.	GRADES C per cent	PER CENT OF GOOD BIRDS (CLASSES A & B)
I	Male	13	18.84	5	7.25	4	5.80	
	Female	11	15.94	30	43.48	6	8.69	
	Total	24	34.78	35	50.72	10	14.49	85.50
II	Male	9	12.16	7	9.46	2	2.70	
	Female	11	14.86	35	47.30	10	13.51	
	Total	20	27.02	42	56.76	12	16.21	83.78

THE FLOOR-SPACE REQUIREMENTS OF BROILERS[1]

TEOFILO M. MENDOZA

According to Ivory (1943), a large percentage of the chicks that survived in a crowded space do not develop into good, healthy, high-producing pullets. He further stated that the stunted effects during brooding periods are carried throughout the life of the fowl. Trask (1946) reported that poor and uneven growth of chicks results in crowded growing conditions, and Mehrhof and O'Steen (1946) claimed that there is less percentage of mortality of chicks having more space than those with less space. According to Tomhave and Seeger (1945), at least 0.6 sq.ft. (557.28 sq. cm.) must be allowed each bird. In order to determine the floor space required by growing chicks for the most economical production of broilers under local conditions, this experiment was conducted in the Departments of Agricultural Engineering and Animal Husbandry from December, 1947, to October, 1948.

MATERIALS AND METHOD

A four-tier homemade battery brooder measuring 4′×6′×6′ (1.22 m × 1.83 m × 1.83 m) was used in this study. This brooder was made of poultry wire and No. 6 wire sides, one-inch mesh, hardware cloth, No. 16 wire, and wooden frames. For the protection of the chicks at night, canvas sheets were provided in such a manner that they could be rolled up and down the sides. This cage was placed in a room in the Poultry Husbandry Building where the sun could reach it for short periods in the morning and in the afternoon.

A total of 462 New Hampshire chicks were used in Experiments 1 and 2, and 154 S. C. White Leghorns were used in Experiment 3. The chicks were placed in the different lots as follows:

LOT	NO. OF CHICKS	FLOOR SPACE TO A BIRD
1	24	1.0 sq. ft. (929.03 sq. cm.)
2	30	0.8 sq. ft. (743.22 sq. cm.)
3	40	0.6 sq. ft. (557.28 sq. cm.)
4	60	0.4 sq. ft. (371.61 sq. cm.)

Floor assignment was made at random in the three trials. Care was taken such that the cage received sunlight during the early morning and in the late afternoon.

The same ration was given to all lots. This ration is the College broiler ration consisting of 40 parts rice bran, 35 parts ground corn, 5 parts copra meal, and 20 parts fish meal, all parts by weight. The short exposure of the chicks to direct sunshine in the morning and in the afternoon was apparently sufficient to supply the vitamin D required by them. There was not a single case of legweakness observed in this study. The feed was made available

[1]Experiment Station Contribution No. 1550. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1949. Prepared under the direction of Professor A. P. Aglibut of the Department of Agricultural Engineering and of Professor F. M. Fronda of the Department of Animal Husbandry.

in all lots at all times. Finely chopped green grass was given in adequate amounts three times a week. Later, fine sand was given as grit.

Records kept. Records were kept of the weights of the chicks at the beginning of each experiment. These weights were taken with an "OHAUS" balance with a capacity of 2000 grams and registering to 0.1 gram. Records of weekly weights were kept until the twelfth week. The amount of feed consumed by the birds on the different floors, occurrence of diseases and mortality among birds, and other observations were also recorded.

DISCUSSION OF RESULTS

Rate of growth. The average weekly weights of the chicks are shown in table 1. This table shows that the initial weights of both the one-day-old chicks of both breeds were practically the same in all lots for each of the trials. At the weaning age, however, the weanlings on the 24-bird lot (lot 1) in the three trials for both breeds weighed slightly higher than the chicks in the other lots. However, the simple T-test, under 5 per cent level, showed that there was not at any time a statistical significant difference in the weights of both breeds. On the assumption that the broilers with the heaviest average weight were considered 100 per cent efficient, the relative efficiencies of the different lots follow:

	LOT 1	LOT 2	LOT 3	LOT 4
Experiment 1.............	100	93.3	93.5	92.1
Experiment 2.............	100	95.5	95.3	93.4
Experiment 3.............	100	98.6	97.3	94.6

When the average rate of growth was expressed in terms of per cent, using the formula of Asmundson and Lerner (1942) $R = \frac{W_2 - W_1}{\frac{1}{2}(W_2 + W_1)} \times 100$, where W_2 is the final weight at the period concerned, and W_1 is the initial weight, it was observed that the rate of growth was not constant and apparently was not influenced by the amount of floor space available to the chicks.

Mortality. In all three experiments, the greatest mortality both for the New Hampshires and the White Leghorns was on the 60-bird lot and the least on the 24-bird lot. Table 2 indicates that, apparently, the more birds there are in the pen, the higher is the mortality. When the compartment with the lowest mortality was considered 100 per cent efficient, the relative efficiencies of the different lots were as follows:

	LOT 1	LOT 2	LOT 3	LOT 4
Experiment 1...........	99.6	68.5	100.0	65.1
Experiment 2...........	93.2	100.0	84.7	50.2
Experiment 3...........	100.0	83.9	83.2	61.1

In the three experiments, the disease suspected to be coccidiosis caused a rather high mortality in the 60-chick compartment. Evidently, these results agree with those reported by Tomhave and Seeger (1945) that the coccidial effects build up more in a more crowded pen. In Experiment 1, the rather high mortality in the fourth week on the 30-bird floor is explained in part by three accidental deaths[2] and a case of cannibalism.

[2]Three chicks accidentally inserted their heads in the wire sides of the cage.

Feed consumption. The figures show that, in both breeds, the average feed consumption was higher in lot 1 (24-bird lot) than in the other lots. This may be partly explained by the fact that the broilers produced were slightly heavier than those in the other lots. Relatively bigger amounts of feed were consumed in the seventh week on the 24-bird floor and in the fourth week on the three other floors in Experiment 1, as well as in the third week on the 40- and 60-bird floors where New Hampshires were used, and in the sixth week on the 24-bird floor and in the fourth week on the 60-bird floor. The amount of feed consumed by the White Leghorn chicks, however, was almost constant.

Table 3 shows that the New Hampshire chicks required a little less feed to produce a unit gain than the S. C. White Leghorn. These figures seem to indicate that in all three trials, a slightly less amount of feed was needed to produce a unit gain in the 40-bird floor for both the New Hampshires and the S. C. White Leghorns. Subjected to the T-test, under 5 per cent level, the differences in the feed consumption of both breeds were statistically insignificant.

Quality of broilers produced. Table 4 shows the quality of the broilers produced. Since the present system of marketing broilers in this country is not placed on any standardized basis of grading, the classifications A, B, and C used in this study were made only according to the size, general appearance, and vigor of the birds.

It may be seen from this table that better quality broilers were produced in lot 1 (24-bird lot) than in any other lot in all the experiments made. It may be seen also that as the number of birds in the lot increased, the percentage of Class A broilers decreased and the percentages of Class B and Class C increased. In lot 3 (40-bird lot) Class C broilers made up 25 per cent of the flock and in lot 4, this class comprised 32.8 per cent of the flock. It may be seen further from table 4 that the results obtained were practically similar in all the experiments made.

SUMMARY AND CONCLUSION

1. Although the average weights of the chicks were observed to increase as the floor space available in each lot was increased, the differences in weight were statistically insignificant.

2. The more birds there were in a pen, the higher was the mortality.

3. The number of chicks on a floor did not seem to affect the rate of growth and the amount of feed consumed to produce a unit gain in weight (gram weight gained per gram of feed consumed).

4. Apparently, the more floor space allowed to a bird, the better the quality of the broiler produced.

5. Taking into consideration all production factors in broiler raising, this study seems to point out that at least 0.6 square foot (557.28 sq. cm.) must be allowed each bird. This allowance is true for both the New Hampshire and the White Leghorn breeds.

LITERATURE CITED

Asmundson, V. S., and I. Michael Lerner. 1942. Breeding chickens for meat production. California Agric. Exper. Sta. Bul. 675: 1–45.

Barger, Edgar Hugh, and Leslie Ellsworth Card. 1943. Diseases and parasites of poultry. 399 p., 83 fig. Philadelphia: Lea and Febiger.

Ivory, Boyd A. 1943. Chick care. South Dakota State College Ext. Serv. Cir. 400: 1–16.

Mehrhof, N. R., and A. W. O'Steen. 1946. Raising chicks, broilers, and pullets. Florida State College Ext. Bul. 128: 1–40.

Tomhave, A. E., and K. C. Seeger. 1945. Floor space requirements of broilers. University of Delaware Agric. Exper. Sta. Bul. 255: 1–22.

Trask, Owen S. 1946. Poultry Primer. University of Connecticut Agric. Ext. Serv. Bul. 378: 1–80.

TABLE 1

Average weights of the birds

LOT NO.	WEIGHING	EXPERIMENT NUMBER 1[a]	2[a]	3[b]
		grams	*grams*	*grams*
1	Initial	40.2 ∓ 0.6	35.9 ∓ 0.7	33.7 ∓ 0.7
	Final	813.6 ∓ 44.8	668.3 ∓ 26.5	532.6 ∓ 19.4
2	Initial	39.9 ∓ 0.6	36.0 ∓ 0.7	33.7 ∓ 0.7
	Final	759.3 ∓ 49.6	638.0 ∓ 35.7	524.1 ∓ 19.4
3	Initial	40.1 ∓ 0.4	35.9 ∓ 0.6	33.8 ∓ 0.6
	Final	760.7 ∓ 25.0	637.2 ∓ 20.3	518.1 ∓ 16.4
4	Initial	39.1 ∓ 0.4	35.8 ∓ 0.6	33.7 ∓ 0.4
	Final	749.7 ∓ 19.8	624.0 ∓ 26.3	504.1 ∓ 19.4

[a] New Hampshire chicks
[b] S. C. White Leghorn chicks

TABLE 2

Mortality of the chicks

LOT NO.	EXPERIMENT NUMBER 1[a]	2[a]	3[b]
	per cent	*per cent*	*per cent*
1	25.1	25.0	33.3
2	36.5	23.3	39.7
3	25.0	27.5	40.0
4	38.4	46.4	54.5

[a] New Hampshire chicks
[b] S. C. White Leghorn chicks

TABLE 3

Amount of feed required to produce a kilogram of broiler

LOT NO.	EXPERIMENT NUMBER		
	1[a]	2[a]	3[b]
	kgm	*kgm*	*kgm*
1	3.87	5.50	4.66
2	4.28	4.66	5.40
3	3.85	4.33	4.33
4	4.66	5.40	5.20

[a] New Hampshire chicks
[b] S. C. White Leghorn chicks

TABLE 4

Quality of broilers produced

LOT NO.	GRADE	EXPERIMENT NUMBER		
		1[a]	2[a]	3[b]
		per cent	*per cent*	*per cent*
1	A	55.5	51.0	50.0
	B	27.7	33.3	31.3
	C	16.8	15.7	18.7
2	A	47.3	43.3	44.4
	B	31.5	39.4	38.9
	C	21.2	17.3	16.7
3	A	43.3	41.3	42.9
	B	30.0	34.4	32.1
	C	26.7	24.1	25.0
4	A	40.5	40.6	38.4
	B	27.0	28.1	27.0
	C	32.5	31.3	34.6

[a] New Hampshire chicks
[b] S. C. White Leghorn chicks

A GENETIC STUDY OF POD AND SEED CHARACTERS IN VIGNA[1]

José M. Capinpin and Teodoro A. Irabagon
Of the Department of Agricultural Botany

Sitao (*Vigna sesquipedalis* Fruwirth), a long-podded pole type of bean, is one of the most popular legumes in the Philippines. In Luzon, especially in the provinces of Nueva Ecija, Pangasinan, Cavite, and Batangas, it is grown mainly for home consumption.

Hedrick (1931) states that there are 60 species of *Vigna* which forms a connecting link between *Dolichos* and *Phaseolus*. The varieties referred to in this study belong to *Vigna sesquipedalis* Fruwirth.

Emerson (1903) noted that dark-colored flowers were usually dominant when a cross was made between white-flowered and dark-flowered plants. This author also reported in 1908 that when totally pigmented beans were crossed with partially pigmented (eyed) beans, total pigmentation occurred exclusively in the first-generation hybrids and bred true in subsequent generations.

Fennel (1948) concluded that in crosses of *Vigna sinensis*, the yard-long bean and the New Era cowpea, the size, shape, and number of seeds are inherited as dominant traits, while seed spacing was transmitted as a recessive trait.

A study of the heredity and variability of flower and seed-coat colors, and pod characters of the "sitao" in connection with an attempt to produce and develop a hybrid from the local varieties, was conducted in the culture plots of the Department of Agricultural Botany, College of Agriculture, Los Baños, Laguna, from November, 1947 to February, 1949.

MATERIALS AND METHODS

Varieties of sitao used. The varieties of sitao used possess contrasting colors of seed coat and flowers and varying lengths of pods. These varieties were obtained in Muñoz, Nueva Ecija, and are known locally as "sitao na pula", "sitao na puti", and "sitao na hubero".

The "sitao na pula" is a trailing, glabrate annual vine. The leaflets are ovate-rhomboid in shape with acute apex. The few racemes that it produces are axillary and long-peduncled. The flowers are purplish with three to six crowded at the end of the peduncle. The calyx is greenish and about one centimeter long. The pods are anthracene-purple to raisin-black, slender, fleshy, and pliant. They shrink about the seeds when dry. The seeds are kidney-shaped, with pale purple-drab color.

The "sitao na puti" has yellowish-green pod, dark-Corinthian purple seed coat, and purple flower.

[1] Experiment Station Contribution No. 1551. Based on the thesis presented for graduation by the junior author with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1949, No. 1620. Prepared in the Department of Agricultural Botany under the direction of the senior author.

The "sitao na hubero" has a yellowish-green pod, purple-eyed seed coat, and white flower. The botanical description of the plant is more or less the same as those of the "sitao na pula" and "sitao na puti".

The contrasting characteristics of these parental types may be seen in table 1.

Test and selection of parent varieties. Preliminary tests were made in order to isolate the purity of the strain to be used in the hybridization work. The three varieties were planted in separate lots, in the immediate vicinity of which no other variety of sitao or cowpea was grown. To insure the use of one-line parentage, only pods gathered from one plant of each variety were grown in the next planting. The seeds for cross-pollination work were sown on February 15, 1948, and the successfully hybridized pods were harvested on May 1 to 20, 1948.

Technique of crossing. The sitao has perfect flowers, each of which has ten stamens and one pistil enclosed in one floral envelope. For hybridization, emasculation was done during the bud stage when the period of dehiscence was determined. Emasculations were performed from 4:00 to 6:00 o'clock in the afternoon when there was no dehiscence. Pollination was done from 6:00 to 8:00 o'clock the next morning. To emasculate, the bud was held between the thumb and the forefinger, with the keel side uppermost. A needle was run along the ridge where the two edges of the petals unite. One side of the petal was brought down, securing its position by exposing the keel. A slit was made from three millimeters below the bend of the keel to about one and one-half millimeters from the stigma. The ten stamens were pulled out with a pair of pointed forceps; they were counted as they were removed to make certain that none was left. The disturbed parts of the keel, wings, and standard were placed in their original positions. The emasculated flowers were then enclosed in a waxed paper bag.

Culture of hybrid materials. The cross-pollinated seeds and their subsequent generations, together with parental materials, were planted and harvested as follows:

SEED MATERIAL	PLANTED	FLOWERED	HARVESTED
F_1 hybrid..............	July 3, 1948	Aug. 16–22, 1948	Sept. to Oct., 1948
F_2 hybrid..............	Nov. 6, 1948	Dec. 22–31, 1948	Jan. to Feb., 1949

Segregation of characters. The observed results of the crosses at the segregating generations were tested with theoretical results by the Chi-square (X^2) method and corresponding values of P for closeness of fit.

DISCUSSION OF RESULTS

Cross-pollination of "sitao". Table 2 shows the data on the artificial pollination of sitao. Direct and reciprocal crosses between varieties were attempted. A low percentage of the mechanically treated flowers set pods. The difficulty in synchronizing flowering periods of the late and early sitao accounts for the low percentage of success in the cross-pollination work. A similar case was observed by Capinpin (1935) and Roy and Richharia (1948). While "sitao na puti" and "sitao na hubero" were at their height of flowering, the "sitao na pula" was just beginning to give signs of setting flower buds. Most of the pods of the artificially pollinated flowers produced more undeveloped than developed seeds.

Table 3 shows the number of hybrids raised and the percentage of mortality among the F_1 and F_2 plants. In the cross "sitao na hubero" × "sitao na pula" none of the plants developed to maturity on account of the heavy infestation of *Aphis laburni* Kaltenbach[2].

Variation and heredity of characters

The cross "sitao na pula" × "sitao na puti". The "sitao na pula" has a pale-purple drab seed coat and is a purple-flowered plant. The fruit is anthracene-purple to raisin-black, has an average pod length of 40.84 ∓ 0.209 centimeters, and matures in more than 62 days, while "sitao na puti" is also a purple-flowered plant producing a dark-Corinthian purple seed coat. The fruit is yellowish-green and matures in more than 52 days. Its average pod length is 32.14 ∓ 0.309 centimeters.

Inheritance of flower color. As shown in table 1, both "sitao na pula" and "sitao na puti" possessed purple flowers. The F_2 plants were all purple-flowered (table 4). No flower-color segregation was observed in the ensuing progeny.

Inheritance of seed-coat color. The seed coat of the "sitao na pula" was pale-purple drab, while that of "sitao na puti" was dark-Corinthian purple. In both crosses, all the F_1 plants produced pale-purple drab seed coats. In the F_2 population, the seed coat segregated into two phenotypes: pale-purple drab and dark-Corinthian purple. Of the 57 individuals, 42 produced pale-purple drab seed coat and 15, dark-Corinthian seed coat. This segregation suggests a monohybrid Mendelian ratio of 3:1. The goodness of fit of the observed ratio was tested not only for monogenic ratio of 3:1 but also for the digenic ratio of 9:7 and trigenic ratio of 37:27. After calculating the goodness of fit, it was definitely established that the pale-purple drab is a simple Mendelian dominant over the dark-Corinthian purple seed coat (tables 5a and 5b).

Inheritance of fruit color. The two varieties possess contrasting fruit color; "sitao na pula" is anthracene-purple fruit-colored, while "sitao na puti" is yellowish-green fruit-colored. All the first-generation hybrid plants produced fruits with anthracene-purple color. In the F_2 population the fruit color segregated into a simple Mendelian monohybrid ratio of 3:1, anthracene-purple being dominant over the yellowish-green fruit color (table 4).

Inheritance of pod length. Table 6 shows that the average pod length of "sitao na pula" was 40.84 ∓ 0.209 centimeters, while that of "sitao na puti", 32.15 ∓ 0.309 centimeters.

The F_1 hybrid plants had an average pod length of 38.60 ∓ 0.918 centimeters and the reciprocal, 37.53 ∓ 0.479 centimeters. The average length of the F_1 plants was intermediate between those of the parents. In the F_2 generations, the average pod length was 35.03 ∓ 0.345 centimeters and the reciprocal, 34.79 ∓ 0.391 centimeters, showing that the long type was partially dominant. According to Roy and Richharia (1948), more than two pairs or perhaps even more than three pairs of genes may be responsible for the expression of pod length.

[2]Identified by Dean Leopoldo B. Uichanco, Professor and Head, Department of Entomology, College of Agriculture, University of the Philippines.

Number of seeds to a pod. The parents "sitao na pula" and "sitao na puti" had an average of 11.52 ∓ 0.253 seeds to a pod (table 7). The seeds of "sitao na pula" are widely spaced in the pods with an average length of 40.84 ∓ 0.209 centimeters; "sitao na puti", 14.87 ∓ 0.316 seeds uniformly spaced in pods with an average length of 32.14 ∓ 0.309 centimeters.

The type of heredity involved in seed number was difficult to ascertain because of the small numerical difference; the number of seeds in a pod follows a rather complex trend in inheritance.

The F_1 hybrid plants in both crosses produced on the average 15.07 ∓ 0.262 and 15.16 ∓ 0.246 seeds to a pod, respectively. Heterosis was manifested; they had greater number of seeds in a pod than the more seeded parent type (table 7). In the F_2 generation the average number of seeds was 12.42 ∓ 0.32 and in the reciprocal, 13.16 ∓ 0.28 (table 7). This corroborates the findings of Capinpin (1935) that in the F_2 generation of the cross between the New Era × White Paayap of cowpea (*Vigna sinensis*) there were 13.44 ∓ 0.178 seeds a pod, which was a close range to that of either parents. Roy and Richharia (1948) also found a similar result; that is, the F_2 generation gave an average of 14.6 ∓ 0.91 seeds a pod, which is closer to the 13-seeded bean plant.

The variation in size of the seeds (table 8) was determined by taking the average weight of ten seeds. The size of the seeds of the F_1 hybrid type was not obtained; the comparison was made between the parents and the F_2 hybrids. The "sitao na pula" parent had a range of 0.95 to 1.71 grams for every ten seeds, with a mean of 1.27 ∓ 0.075 grams; the "sitao na puti" variety had a range of 0.70 to 1.73 grams for every ten seeds, with an average of 1.10 ∓ 0.093 grams. In the F_2 generation the range was 0.95 to 1.83 grams, with an average of 1.34 ∓ 0.083; in the reciprocal, the range was 0.90 to 1.92 grams, with an average of 1.33 ∓ 0.92 grams. The F_2 seeds weighed more than either of the parents.

Maturity. The parent plants varied in the time of maturity from the date when the first flower opened.

The time of flowering among the F_2 population and 20 plants of each parent was observed. The "sitao na pula" parent had a maturity range of 55 to 70 days, with an average of 62.14 ∓ 0.37 days; "sitao na puti", a range of 46 to 64 days, with an average of 52.05 ∓ 0.33 days (table 9) The average time of flowering in the F_2 plants was 55.79 ∓ 0.57 days (table 9). This agrees with the results obtained by Mackie (1946) that the time of maturity in cowpea is definitely inherited, and that the late-maturing trait seems to be dominant over the early maturing characteristic.

The cross "sitao na puti" × "sitao na hubero". These two parental varieties of sitao possess different flower colors. "Sitao na puti" is purple-flowered, while "sitao na hubero" is white-flowered. The periods of maturity of the two varieties were almost the same, being 52.05 ∓ 0.33 days for "sitao na puti" and 49.84 ∓ 0.36 days for "sitao na hubero" (table 9).

Both varieties have yellowish-green pods. In pod length "sitao na puti" measures 32.15 ∓ 0.309 centimeters and "sitao na hubero", 24.75 ∓ 0.308 centimeters (tables 3 and 6).

Inheritance of flower color. The first filial generation of the cross "sitao na puti" × "sitao na hubero" and of the reciprocal were all purple-flowered. When such purple-flowered F_1 plants were self-fertilized, the F_2 progeny

produced had two phenotypic colors. Of the 159 individuals in the F_2 generation of the cross "sitao na puti" × "sitao na hubero", 120 were purple-flowered and 39 white-flowered (table 4). This segregation follows a simple Mendelian monohybrid ratio of 3:1, which clearly showed that the purple flower was dominant over the white. This flower-color segregation corroborates Harland's (1919) report that the F_2 segregation of flower color in cowpea was rather simple. Emerson (1911) also observed that dark flowers are usually dominant when a cross is made between white-flowered and dark-flowered plants.

Inheritance of seed-coat color. The inheritance of seed-coat colors, pattern, and eyes has been well worked out by several investigators. Mackie (1946) reported that Spillman in 1911 found eyed character inherited with a 3:1 ratio of self-colored to eyed types, the eyed form behaving as recessive.

In the cross between "sitao na puti" and "sitao na hubero" and the reciprocal, the F_1 plants had a dark-Corinthian purple seed coat; when selfed, the F_2 generation segregated into 120 dark-Corinthian purple to 39 purple-eyed seed coat (table 4). The goodness of fit was tested to the 3:1 ratio for monohybrid segregation, 9:7 ratio for digenic segregation, and to 37:27 ratio for trigenic segregation. The values calculated (tables 5c and 5d) seem to indicate that the dark-Corinthian purple seed coat is a simple dominant over the purple-eyed.

Inheritance of pod color. No genetic observations were made on the mode of inheritance in pod color, for both parents had yellowish-green pods. The pods of the F_1 generation of all crosses were all yellowish-green, and all the plants in the F_2 generation produced also this pod color (table 4).

Inheritance of pod length. Tables 1 and 6 show the average pod length of "sitao na puti" and "sitao na hubero". The F_1 plants had an average of 30.07 ∓ 0.447 centimeters and the reciprocal, 28.96 ∓ 0.394 centimeters. The F_2 plants produced an average pod length of 26.73 ∓ 0.377 centimeters and the reciprocal, 25.28 ∓ 0.269 centimeters. These findings clearly show that pod length is partially dominant and that two or more pairs of genes are responsible for the expression of pod length.

Number of seeds to a pod. Both the parents, "sitao na puti" and "sitao na hubero", had approximately the same number of seeds in a pod (table 7).

The F_1 generation of the cross "sitao na puti" × "sitao na hubero" produced an average of 16.75 ∓ 0.260 seeds in a pod; of the reciprocal, 16.55 ∓ 0.302. When selfed, the F_2 generation gave an average of 13.68 ∓ 0.290; the reciprocal, 13.41 ∓ 0.260 (table 7).

Table 7 also shows that heterosis is again manifested in the first filial generation of the cross "sitao na puti" × "sitao na hubero" with respect to number of seeds.

Table 8 shows the average weight of ten seeds of the parents "sitao na puti" and "sitao na hubero". The F_2 generation had a range of 0.98 to 1.72 grams, with an average of 1.45 ∓ 0.05 grams; the reciprocal, a range of 0.90 to 1.84 grams, with an average of 1.34 ∓ 0.084 grams. The seeds of the F_2 generation weighed more than either of the parents; their variability in number and weight of seeds appeared to be constant.

Maturity. Based on the first opening of their flowers, the "sitao na puti" and "sitao na hubero" matured almost at the same time. Table 9

shows the average number of days both parents required to reach maturity. In the F_2 generation the average number of days of maturity was 50.61 ∓ 0.31.

The cross "sitao na pula" × "sitao na hubero". The parent "sitao na pula" was late maturing, and the parent "sitao na hubero" was early maturing. "Sitao na pula" has an 11-seeded, anthracene-purple pod 40.84 ∓ 0.209 centimeters (average pod length) long, and pale-purple drab seed coat. "Sitao na hubero" has a 14-seeded, yellowish-green pod with an average length of 24.74 ∓ 0.308 centimeters, purple-eyed seed coat, and white flowers.

Inheritance of flower color. Table 3 shows the flower color of the parents "sitao na pula" and "sitao na hubero".

The first filial generations were all purple-flowered. When selfed, the F_2 generation (table 4) segregated into 27 purple-flowered to 10 white-flowered. It followed a simple Mendelian ratio of 3:1, the purple-flowered being dominant over the white-flowered. This mode of inheritance is similar to the report of Capinpin (1935) that purple-flowered cowpea is dominant over the white-flowered White Paayap, with a simple Mendelian ratio of 3:1.

Inheritance of seed-coat color. Table 1 shows the seed-coat color of "sitao na pula" and "sitao na hubero". The seeds of the F_1 plants had pale-purple drab seed coat. The F_2 population segregated into 27 pale-purple drab to 10 purple-eyed seed coat, with a P value of 0.7797. After calculating the goodness of fit, it was found that the pale-purple drab seed coat was dominant over the purple-eyed. (table 5e).

Inheritance of pod color. In the cross "sitao na pula" × "sitao na hubero", the F_1 plants were all anthracene-purple pod colored. In the F_2 the pod color segregated into anthracene-purple and yellowish-green (table 4).

Inheritance of pod length. The pod length of "sitao na hubero" is about one-half that of "sitao na pula" (table 6). In the F_1 generation, the fruit length had an average of 36.28 ∓ 0.521 centimeters. In the F_2 generation, the average pod length was 30.40 ∓ 0.396 centimeters, tending toward the short fruit of "sitao na hubero". Roy and Richharia (1948) reported that pod length inheritance is more or less the "accumulative effect of the quantitative character" of length which seems to be partially dominant.

Number of seeds in a pod. Roy and Richharia (1948) reported that the work on inheritance of seed number in each pod in varieties of cowpea (*Vigna sinensis*) having more or less the same number of seeds to a pod, is rather difficult. Table 7 shows the average number of seeds in each pod of the parent plants, "sitao na pula" and "sitao na hubero". In the F_1 generation, the average number of seeds to a pod was 14.20 ∓ 0.264; when selfed, the average number of seeds in a pod was 12.79 ∓ 0.30.

Table 8 shows the average weight for every ten seeds of both parents, "sitao na pula" and "sitao na hubero". In the F_2 plants, the range was 0.94 to 1.84 grams, with an average of 1.33 ∓ 0.087 grams; this weight exceeds that of either parents.

Maturity. Table 9 shows that "sitao na hubero" is early maturing and "sitao na pula", late maturing. In the F_1 plants, the first-opened flower

was observed 50 days after planting, and the average time of maturity was 50.09 ∓ 0.48 days. In the F_2 plants, the average number of days to attain maturity was 55.59 ∓ 0.62, showing that the late-maturing was partially dominant over the early maturing type.

Combination of economic characters effected in the crosses

The parental types used in this hybridization work possessed more or less the same fruit texture, but for purposes of differentiation, "sitao na puti" and "sitao na hubero" had a brittle fruit, while "sitao na pula" had a pliant fruit.

"Sitao na puti" is more preferred in the market than "sitao na hubero" and "sitao na pula". In most home gardens, backyards, and in the "kaingin", "sitao na puti" is widely planted. The objection to the raising of "sitao na pula" is that it matures late. When used as green pod, the resulting soup is tinted with purple color, which is considered an objectionable feature.

The F_2 segregates of "sitao na pula" × "sitao na hubero" produced pods longer than "sitao na hubero" but shorter than "sitao na pula", and more seeds in a pod than "sitao na pula". In the cross "sitao na pula" × "sitao na puti", F_2 segregates produced pods longer than "sitao na puti" but shorter than "sitao na pula", and more seeds in a pod than the "sitao na pula".

SUMMARY

1. The inheritance of flower color in the crosses "sitao na puti" × "sitao na hubero" and "sitao na pula" × "sitao na hubero", was unifactorial; purple was dominant over white, with a 3:1 ratio.

2. Following a monogenic type of inheritance, both the dark-Corinthian purple and the pale-purple drab seed coats were dominant over the purple-eyed seed coat. The segregation was produced in the crosses "sitao na puti" × "sitao na hubero" and "sitao na pula " × "sitao na hubero".

3. Anthracene-purple to raisin-black pod was dominant over the yellowish-green pod, with a 3:1 Mendelian ratio. The crosses giving this segregation were "sitao na pula" × "sitao na puti" and "sitao na pula" × "sitao na hubero".

4. The F_1 plants showed a more or less intermediate maturity period, the late maturing being partially dominant. The crosses which showed this segregation were "sitao na pula" × "sitao na puti" and "sitao na pula" × "sitao na hubero".

5. Length of pod of the F_1 plants was more or less intermediate between those of the parents. In the F_2 plants, the fruit length tended to resemble those of the short parents. It is possible that more than two pairs of genes are responsible for the inheritance of fruit length. The parental types and crosses involved were "sitao na pula" × "sitao na puti", "sitao na puti" × "sitao na hubero", and "sitao na pula" × "sitao na hubero".

6. The number of seeds to a pod in the parent was more or less the same. The determination of inheritance in the number of seeds per pod was rather difficult because the difference between the hybrids of any two crosses was rather small. Hybrids which manifested heterosis on the basis

of number of seeds were the F_1 of the crosses "sitao na pula" × "sitao na puti", "sitao na puti" × "sitao na hubero", and "sitao na pula" × "sitao na hubero."

7. The average weight of ten seeds of the F_2 generation clearly exceeded the weight of either of the parents.

8. The F_2 hybrids produced by the crosses "sitao na pula" × "sitao na puti" and "sitao na pula" × "sitao na hubero" showed uniformity in seed spacing and longer pods than "sitao na puti" and "sitao na hubero".

LITERATURE CITED

CAPINPIN, J. M. 1936. A genetic study of certain characters in varietal hybrids of cowpea. Philippine Jour. Sci. **57** (2): 149–163. *Plate 1, fig. 1–2.*

EMERSON, R. A. 1903. Heredity in bean hybrids (*Phaseolus vulgaris*). Nebraska Sta. Record. 33–68. *Cited in* U. S. Exper. Sta. Rec. **16:** 563. 1904–1905.

EMERSON, R. A. 1908. The inheritance of color in seeds of beans (*Phaseolus vulgaris*) Nebraska Sta. Record. 65–101. *fig. 4. Cited in* U. S. Exper. Sta. Rec. **22:** 40. 1910.

FENNEL, JOSEPH H. 1948. New cowpea resistant to mildew. Jour. Hered. **39:** 275–278. *Fig. 1–2.*

HEDRICK, U. P. 1931. The vegetables of New York. N. Y. State Agric. Exper. Sta. **1:** (Part II) Beans of New York.

MACKIE, W. W. 1946. Blackeye beans in California. Calif. Agric. Exper. Sta. Bull. 696. *Fig. 1–24.*

ROY, S. A. AND R. H. RICHHARIA. 1948. Breeding and inheritance studies on cowpeas *Vigna sinensis.* Jour. Amer. Soc. Agron. **40:** (6): 479–489. *Fig. 1–2.*

TABLE 1

Characters of the parental types, "sitao na pula", "sitao na puti", and "sitao na hubero"

TYPES	FRUIT LENGTH	FRUIT COLOR	SEED-COAT COLOR	FLOWER COLOR	MATURITY FIRST FLOWERS	AV. NO. OF SEEDS PER POD
	cm.				*days*	
"Sitao na pula"....	40.845∓0.2096	Anthracene-purple to raisin-black	Pale-purple drab	Purple	Av. 62.14∓0.27 55 to 70	11.516∓0.2535
"Sitao na puti".....	32.146∓0.3091	Yellowish-green	Dark-Corinthian purple	Purple	Av. 52.05∓0.33 46 to 64	14.877∓0.3162
"Sitao na hubero"..	24.745∓0.3080	Yellowish-green	Purple-eyed	White	Av. 49.84∓0.36	14.290∓0.2803

TABLE 2

Result of cross-pollinating "sitao na pula", "sitao na puti", and "sitao na hubero"

PARENTAL TYPES	DATE OF POLLINATION	FLOWERS TREATED	DATE OF HARVEST	POLLINATED PODS HARVESTED	
				No. of pods	*per cent*
"Sitao na pula" × "sitao na puti"......	April 11–27, 1948	34	May 1-20, 1948	2	5.88
"Sitao na puti" × "Sitao na pula"......	April 11–27, 1948	50	May 1–20, 1948	3	6.00
"Sitao na puti" × "Sitao na hubero"....	April 5–24, 1948	48	April 20 to May 10, 1948	6	12.50
"Sitao na hubero" × "Sitao na puti"......	April 5–24, 1948	45	April 20 to May 10, 1948	5	11.11
"Sitao na pula" × "Sitao na hubero"...	April 11–29, 1948	16	May 1–20, 1948	1	6.25
"Sitao na hubero" × "Sitao na pula".....	April 11–29, 1948	14	May 1–20, 1948	1	7.14

TABLE 3

Number of hybrids and percentage of mortality

HYBRIDS	NO. OF SEEDS PLANTED	NO. OF SEEDS GERMINATED	NO. OF PLANTS GROWN TO MATURITY	PERCENTAGE OF GERMINATION	PERCENTAGE OF MORTALITY
F_1					
"Sitao na pula" × "Sitao na hubero"….	8	6	5	77.77	16.66
"Sitao na hubero" × "Sitao na pula"……	4	2	0	50.00	100.00
"Sitao na puti" × "Sitao na hubero"…..	24	20	18	83.33	10.00
"Sitao na hubero" × "Sitao na puti"…….	20	16	13	80.00	18.75
"Sitao na puti" × "Sitao na pula"…….	10	7	4	70.00	42.85
"Sitao na pula" × "Sitao na puti"…….	6	5	3	83.33	40.00
F_2					
"Sitao na pula" × "Sitao na hubero…..	40	35	32	87.50	8.57
"Sitao na puti" × "Sitao na hubero"…..	180	171	159	90.00	7.01
"Sitao na hubero" × "Sitao na puti"…….	150	142	135	94.66	4.93
"Sitao na puti" × "Sitao na pula"…….	54	41	35	75.92	14.63
"Sitao na pula" × "Sitao na puti"…….	71	60	57	84.64	5.00

TABLE 4

Relationship of flower, fruit and seed-coat colors in an F_2 Vigna hybrid population

TYPES	INDIVIDUALS		FLOWER COLOR	FRUIT COLOR	SEED-COAT COLOR
"Sitao na pula" × "Sitao na puti"	57	42	Purple	Anthracene-purple	Pale-purple drab
		15	Purple	Yellowish-green	Dark-Corintian purple
"Sitao na puti" × "Sitao na pula"	35	26	Purple	Anthracene-purple	Pale-purple drab
		9	Purple	Yellowish-green	Drak-Corinthian purple
"Sitao na puti" × "Sitao na hubero"	159	120	Purple	Yellowish-green	Dark-Corinthian purple
		39	White	Yellowish-green	Purple-eyed
"Sitao na hubero" × "Sitao na puti"	135	102	Purple	Yellowish-green	Dark-Corinthian purple
		33	White	Yellowish-green	Purple-eyed
"Sitao na pula" × "Sitao na hubero"	37	27	Purple	Anthracene-purple	Pale-purple drab
		10	White	Yellowish-green	Purple-eyed

TABLE 5*a*

F_2 segregation in seed-coat color of the cross "sitao na pula" × "sitao na puti"

PHENOTYPE RATIO	PALE-PURPLE DRAB	DARK-CORINTHIAN PURPLE
3:1 (Observed	42	15
(Calculated	42.75	14.25
Monogenic	X^2 = 0.0526	P = 0.8237
9:7 (Observed	42	15
(Calculated	32.06	24.94
Digenic	X^2 = 7.0401	P = 0.01
37:27 (Observed	42	15
(Calculated	32.95	24.05
Trigenic	X^2 = 5.8874	P = 0.0148

TABLE 5*b*

Seed segregation in seed-coat color of the cross "sitao na puti" × "sitao na pula"

PHENOTYPE RATIO	PALE-PURPLE DRAB	DARK-CORINTHIAN PURPLE
3:1 (Observed	26	9
(Calculated	26.25	8.75
Monogenic	X^2 = 0.0095	P = 0.9270
9:7 (Observed	26	9
(Calculated	19.69	15.31
Digenic	X^2 = 4.6263	P = 0.0350
37:27 (Observed	26	9
(Calculated	20.23	14.77
Trigenic	X^2 = 3.9042	P = 0.0488

TABLE 5*c*

F_2 segregation in seed-coat color of the cross "sitao na puti" × "sitao na hubero"

PHENOTYPE RATIO	DARK-CORINTHIAN PURPLE	PURPLE-EYED
3:1 (Observed	120	39
(Calculated	119.25	39.75
Monogenic	X^2 = 0.0189	P = 0.8940
9:7 (Observed	120	39
(Calculated	89.44	69.56
Digenic	X^2 = 23.8715	P = 0.01
37:27 (Observed	120	39
(Calculated	19.92	67.08
Trigenic	X^2 = 20.3298	P = 0.01

TABLE 5*d*

F_2 segregation in seed-coat color of the cross "sitao na hubero" × "sitao na puti"

PHENOTYPE RATIO		DARK-CORINTHIAN PURPLE	PURPLE-EYED
3:1 Monogenic	(Observed	102	33
	(Calculated	101.25	33.75
		X^2 = 0.0222	P = 0.8870
9:7 Digenic	(Observed	102	33
	(Calculated	75.94	59.06
		X^2 = 20.4455	P = 0.01
37:27 Trigenic	(Observed	102	33
	(Calculated	78.05	56.95
		X^2 = 17.4254	P = 0.01

TABLE 5*e*

F_2 segregation in seed-coat color of the cross "sitao na pula" × "sitao na hubero"

PHENOTYPE RATIO		PALE-PURPLE DRAB	PURPLE-EYED
3:1 Monogenic	(Observed	27	10
	(Calculated	27.75	9.25
		X^2 = 0.0811	P = 0.7797
9:7 Digenic	(Observed	27	10
	(Calculated	20.81	16.19
		X^2 = 4.2046	P = 0.0431
37:27 Trigenic	(Observed	27	10
	(Calculated..........	21.39	15.61
		X^2 = 3.5464	P = 0.0630

TABLE 6

Comparison in length of pods of the parents and the F_1 and F_2 generations of the crosses "sitao na pula", "sitao na puti" and "sitao na hubero", and reciprocal

TYPES	F_1	F_2
	cm.	*cm.*
"Sitao na pula" (P)[a]	40.84∓0.2096	
"Sitao na puti" (P)	32.15∓0.3091	
"Sitao na hubero" (P)	24.74∓0.3080	
"Sitao na pula" × "Sitao na puti"	38.60∓0.9180	35.03∓0.345
"Sitao na puti" × "Sitao na pula"	37.53∓0.4799	34.79∓0.391
"Sitao na puti" × "Sitao na hubero"	30.07∓0.4470	26.73∓0.377
"Sitao na hubero" × "Sitao na puti"	28.96∓0.3944	25.28∓0.269
"Sitao na pula" × "Sitao na hubero"	36.28∓0.5212	30.40∓0.396

[a] Stands for parent plants.

TABLE 7

Average number of seeds in each pod of the parents and F_1 and F_2 generations of the crosses between "sitao na pula", "sitao na puti" and "sitao na hubero", and reciprocal

TYPES	F_1	F_2
"Sitao na pula" (P)[a]	11.52∓0.2535	
"Sitao na puti" (P)	14.87∓0.3162	
"Sitao na hubero" (P)	14.29∓0.2303	
"Sitao na pula" × "Sitao na puti"	15.07∓0.2622	12.42∓0.32
"Sitao na puti" × "Sitao na pula"	15.16∓0.2467	13.16∓0.28
"Sitao na puti" × "Sitao na hubero"	16.75∓0.2605	13.68∓0.29
"Sitao na hubero" × "Sitao na puti"	16.55∓0.3029	13.41∓0.26
"Sitao na pula" × "Sitao na hubero"	14.20∓0.2640	12.79∓0.30

[a] Stands for parent plants.

TABLE 8

Comparison in weight of ten seeds of F_2 generations and their parents

TYPES	RANGE	MEAN WEIGHT OF TEN SEEDS
	grams	*grams*
"Sitao na pula" (P)[a]	0.95 to 1.71	1.27 ∓ 0.0751
"Sitao na puti" (P)	0.70 to 1.73	1.10 ∓ 0.0934
"Sitao na hubero" (P)	0.92 to 1.78	1.26 ∓ 0.0989
"Sitao na pula" × "Sitao na puti"	0.95 to 1.83	1.34 ∓ 0.0836
"Sitao na puti" × "Sitao na pula"	0.90 to 1.92	1.33 ∓ 0.0924
"Sitao na puti" × "Sitao na hubero"	0.98 to 1.72	1.45 ∓ 0.0515
"Sitao na hubero" × "Sitao na puti"	0.90 to 1.84	1.34 ∓ 0.0842
"Sitao na pula" × "Sitao na hubero"	0.94 to 1.84	1.33 ∓ 0.0879

[a]Stands for parent plants.

TABLE 9

Relationship in the time of maturity between parents and F_1 and F_2 Vigna hybrids

TYPES	RANGE	AV. MATURITY
	days	*days*
"Sitao na pula" (P)[a]	55 to 70	62.14 ∓ 0.37
"Sitao na puti" (P)	46 to 64	52.05 ∓ 0.33
"Sitao na hubero" (P)	45 to 57	49.84 ∓ 0.36
"Sitao na pula" × "Sitao na puti" and reciprocal (F_1)	47 to 65	57.42 ∓ 0.47
"Sitao na puti" × "Sitao na hubero" and reciprocal (F_1)	44 to 64	50.06 ∓ 0.36
"Sitao na pula" × "Sitao na hubero" (F_1)	50 to 70	59.09 ∓ 0.48
"Sitao na pula" × "Sitao na puti" and reciprocal (F_2)	50 to 78	55.79 ∓ 0.57
"Sitao na puti" × "Sitao na hubero" and reciprocal (F_2)	46 to 67	50.61 ∓ 0.31
"Sitao na pula" × "Sitao na hubero" (F_2)	50 to 65	55.59 ∓ 0.62

[a]Stands for parents plants.

TOP-WORKING PUMMELO TREES BY GRAFTINARCHING[1]

LEON G. GONZALEZ AND CARLOS R. CASAL
Of the Department of Agronomy

WITH ONE TEXT FIGURE

A study to determine the suitability of graftinarching for top-working undesirable pummelo trees was made from November, 1947, to February, 1949, in the pomology nursery and in the citrus orchard of the College.

MATERIALS AND PROCEDURE

For this study, 45 healthy trees which were germinated in December, 1927, from seeds of a Chinese pummelo were selected from among those bearing fruit of poor quality. Of 150 scions, 35 were used in graftinarching; 45, in bark grafting; and 75 buds, in shield budding.

The scions were obtained from a superior College of Agriculture seedling variety and from budded trees of the so-called Siamese seedless pummelo. The C. A. variety was the only one out of 123 trees that bore fruit possessing eating qualities similar to but not quite comparable to those of choice imported Chinese pummelo. The Siamese seedless pummelo, said to have been introduced into the Philippines from Siam, was perhaps an inferior form of the Kao Phuang variety.

As stocks for inarching, two-year-old pummelo seedlings were used. The seedlings, planted in pots and nursery rows, were selected for vigor and apparent freedom from attacks of serious diseases and pests.

Ordinary budding and grafting tools, materials and laboratory facilities for growth measurements, sprayers and spray mixtures, ant pastes, and other chemicals were used.

The two-year-old seedlings were balled and transferred to one-gallon cans. To facilitate inarching, bamboo platforms to reach the level of the lower branches were built around the sources of scions. The scions and stocks were matched in size, incised, placed together so the cambium layers would coincide in greater parts, and tied together with strips of either electric tape or budding tape prepared for the purpose (1-2-2 parts by weight of beeswax, beef tallow, and resin). A few of the inarches were tied with cotton string to serve as indicators for the time of severing the inarches, the time depending on the degree of union between the stock and the scion. When they had united sufficiently as indicated by the callus formed along the point of contact, the inarch was severed from the tree so that it would not suffer any unnecessary straining even when the top of the stock was cut just above the scion immediately below the point of union. The wound was covered with kerosene-asphaltum mixture. All the leaves of

[1]Experiment Station Contribution No. 1552. Based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1949, No. 1609. Prepared in the Department of Agronomy under the direction of the senior author.

the newly inarched plants were cut crosswise in halves to minimize evaporation. Then the plants were placed in the shade in the nursery and taken care of until well established.

The fifteen trees selected for top-working were first cut about one and one-half meters above the ground with a sharp bolo. Then a two-man crosscut-saw was used in cutting the stump about half a meter lower. The cut surface was smoothened with a sharp knife. The previously inarched plant, which was to serve as scion in the top-working process, was re-incised in a convenient place as for inarching. A piece of bark about the same width and length as that cut from the scion was removed from the stump; the two cut portions (the scion and the stock) were placed snugly together and nailed. In most cases, cut bamboo pieces were needed as supports to raise the scion to the correct height. Depending on the circumference of the trunk to be top-worked, two or more scions were used, placed as evenly distanced as possible. All exposed cuts were covered with a thick preparation of asphalt-kerosene mixture. Shade was provided for by improvising a temporary shed out of cut pieces of bamboo or branches of ipil-ipil and a thatch of cogon or old fronds of coconut. The stump was whitewashed with a thin mixture of slaked lime and waste cassava starch to minimize sunscalding. The grafts were watered from time to time and the space around the tree cleared of weeds and given surface dressing of about half a kilogram of ammonium sulfate, depending on the size of the tree. Later on ant-paste was applied around the trunk about one foot above the ground to keep out the red ants (*Oecophylla smaragdina* Fabricius). New shoots arising from the stump, other than those near the cut surface which would contribute to a faster healing of the wound, were rubbed off as soon as they appeared. When the grafts appeared to have combined satisfactorily with the stump, the latter was severed just below the point of union. The cut was made as smooth as possible and covered with asphalt-kerosene mixture. When the grafts had already started growing, the shade was gradually removed to let in more sunshine necessary for the faster development of the grafts. Sunscalding was minimized by proper remedial measures.

The fifteen trees selected at random and chosen from among those with bark that slipped easily for bark grafting, were cut down and the stumps made ready for grafting. The scions with prominent buds, vigorous, one to one and one-half centimeters in circumference, round, and nine to ten centimeters long, were cut diagonally about two and a half to three centimeters long and carefully inserted into the slit of the trunk between the bark and the wood. Insertion was made to the last half centimeter of the scion. Two or more scions, depending on the size of the stock, were inserted as in graftinarching and tied around the trunk with twine to keep the scions in position. All exposed portions of the stock and scions were covered with melted paraffin and Sphagnum moss placed snugly around the trunk where the incised portion of the scions were inserted, thus completely covering the top of the scions. After three weeks, the condition of the grafts was determined by lifting the moss and putting it back. The moss was removed gradually to minimize etiolation of the new shoots coming from the living scion. The shoots that did not originate from the scions were rubbed off. Stumps not successfully top-worked were recut and the operation repeated until they were successfully top-worked. The trunk

was given the necessary whitewashing and the grafted trees, the necessary care and shade.

The fifteen trees in the third batch for shield budding were cut as above, the wounds covered, the trunks whitewashed, provided with shade, and allowed to produce shoots. When the shoots were of the right size, about that of a lead pencil, for shield budding, four to six of them strategically located in different parts of the stock were allowed to remain. The rest were rubbed off.

The shoots were shield budded in the ordinary way, with selected bud sticks from the same sources of scion used in graftinarching and bark grafting.

The budding was continued until all the branches had been successfully top-worked.

Measurements of length in centimeters and girth in millimeters of the living scions were taken every month for a period of one year. The cost of operation in top-working and the estimated cost of firewood from the cut portions of the top-worked tree were recorded.

RESULTS AND DISCUSSION

The results of this study (table 1) show significant differences among methods of top-working. The analysis of variance resulted in a calculated F-value, both for set and method, far exceeding the tabular value even at one per cent level (calculated value: set, 30.55; method, 24.79; versus 21.20 tabular value for one per cent). According to the results, graftinarching was the best method for top-working the pummelo (fig. 1); bark grafting, second; and shield budding, last. The mean values in percentage of success were 83.33, 73.33, and 48.00 for the three methods, respectively, with an L.S.M.D. of 8.23.

In other countries, there is little difficulty in top-working undesirable trees by shield budding, bark or crown grafting, and cleft grafting. Under Philippine conditions, the training and experience needed by the plant propagator to achieve success in these methods may be a limiting factor. Climatic differences between temperate and sub-temperate countries, where top-working has been successfully practiced, and tropical regions, where the incidence of high degree of failure is common, is another factor. In spite of these difficulties, graftinarching is preferable to the other methods mentioned. Inarching of closely related plants is perhaps the most dependable of all methods of plant propagation.

The computed value for set likewise shows a high degree of significance. The mean value for set 1 is 46.89, for set 2, 70.67; and for set 3, 87.11. Although the results from the different sets varied significantly, the relative efficiency in terms of percentage of success for the three methods was maintained throughout the experiment.

The two possible reasons for the gradual increase in the number of successful grafts in the different sets are: the possible improvement in efficiency, resulting from continued practice, and differences in weather conditions; the first was done in February, the second in March, and the third, in June, 1948. Around Los Baños the dry weather, which is usually prevalent during April, affected the first two sets but not the third.

In graftinarching for top-working pummelo trees, two-year-old pummelo seedlings planted in small earthen pots or cans and some growing

Fig. 1—A successfully graftinarched citrus tree one year after operation.

in open nursery rows, were repotted in one-gallon cans. A day laborer working eight hours a day could re-pot 40 to 50 plants and place them under partial shade in the nursery.

After 100 to 120 days, the seedlings were exposed gradually to the sun and watered more frequently and more liberally.

A platform around the tree to be used as the source of scions was prepared. The platform held 30 plants in the process of inarching.

The writers prepared 30 to 40 inarches a day.

The growth in height and the increase in girth of the scions varied markedly, depending on the method of propagation used. Those in graftinarching grew the fastest, followed by those in bark grafting, and the least in shield budding. The total growths in length were 24.64, 18.38, and 12.46 centimeters, in the order the different methods are given; and for girth, 9.2, 5.6, and 7.1 centimeters, also in the same order (table 2).

The approximate cost of top-working an average ten-year-old pummelo tree was computed as follows:

Cost of two previously inarched plant-scions	₱2.00
Cost of cutting done by two laborers, each earning about 30 centavos an hour, for three-fourth of an hour each	0.45
For preparing the cut-trunk and branches for firewood	0.60
For inserting scions, whitewashing the tree, and providing shade for the top-worked tree to complete graftinarching	0.60
Cost of miscellaneous materials	₱1.00
Total cost	₱4.65
Proceeds from the firewood, on the average of one-third cord a tree at ₱7.00 a cord, undelivered	2.00
Balance	₱2.65

In 80 to 95 days, the inarches were ready for cutting. This was indicated by the degree of callus formation in the cut portion of the inarches, which were markedly noticeable in those tied with cotton string. The main criterion was the number of plants that continued to live.

The greatest number of living plants were obtained from those tied with cotton string, 90 per cent; next, by those with the budding tape, 75 per cent; and the least, those with electric tape, 45 per cent (table 3). In other experiments in the Department of Agronomy, similar unfavorable results were obtained from the use of electric tape. The senior author attributes it to (1) the greater absorption of heat due to the black color of the tape, (2) possible diminution of the oxygen intake by the covered region, and (3) probable toxic component of the tape itself.

SUMMARY

1. Three different methods of plant propagation, shield budding, bark grafting, and graftinarching, were tested as a means of top-working 45 undesirable pummelo trees. Significant differences were obtained: graftinarching gave the highest percentage of success, 83.33; followed by bark grafting, 73.33; and shield budding, 48.00. The L.S.M.D. was computed at 8.23.

2. Variance values due to set were likewise found significant. The first set was performed on February 1, 1948, with an average success of 46.89 per cent; for the three methods used for the second set in March, 70.67 per cent; for the third set in June, 87.11 per cent.

3. For inarching, the seedlings have to be grown usually from seeds, placed in cans when they have reached a convenient size, allowed to get established, inarched with branches of choice varieties, severed, and then allowed to regain normal growth under optimum conditions.

4. Graftinarching consists in cutting down the tree to a convenient height, re-inarching the stump as in bark grafting using the previously asexually propagated plants as the scions, and giving optimum conditions to the tree operated on until the scions have united with the stock.

5. Using one- to two-year-old seedlings, it takes, on the average, about six months to prepare the scion-inarches, six months to top-work by graftinarching, and about two years to bear fruit.

6. Scions inserted by graftinarching grow much faster than those in bark grafting and shield budding.

7. Top-working by graftinarching is the most promising method for improving our inferior fruit trees, which, in pummelos, would constitute more than 99 per cent of established trees of seedling origin.

TABLE 1

The comparative efficiency of bark grafting, shield budding, and graftinarching as methods for top-working pummelo trees

METHOD	SET NO.	NO. OF TOP-WORKED TREES	NO. OF SCIONS		PERCENTAGE OF SUCCESS
			Inserted	Living	
Bark grafting	1	5	15	7	46.67
	2	5	15	12	80.00
	3	5	15	14	93.33
	Total	15	45	33	220.00
	Average	5	15	11	73.33
Shield budding	1	5	25	6	24.00
	2	5	25	13	52.00
	3	5	25	17	68.00
	Total	15	75	36	144.00
	Average	5	25	12	48.00
Graftinarching	1	5	10	7	70.00
	2	5	10	8	80.00
	3	5	10	10	100.00
	Total	15	30	25	250.00
	Average	5	10	8.33	83.33

Analysis of variance

SOURCES OF VARIATION	DF	SS	VARIANCE	CALC. F VALUE	TAB. F. VALUE	
					.05	.01
Set	2	2453.36	1226.68	30.55	7.71	21.20
Method	2	1990.21	995.10	24.79		
Error	4	160.56	40.14			
Total	8	4604.13				

L. S. M. D. = 8.23

TABLE 2

Growth increment of the scions used in the different methods

GROWTH MEASUREMENT AT MONTHLY INTERVAL	BARK GRAFTING (AVERAGE OF 33 SCIONS)		SHIELD BUDDING (AVERAGE OF 36 SCIONS)		GRAFTINARCHING (AVERAGE OF 25 SCIONS)	
	Length	Girth	Length	Girth	Length	Girth
	cm.	*mm.*	*cm.*	*mm.*	*cm.*	*mm.*
1	1.01	0.00	1.13	0.2	2.54	0.8
2	0.97	0.1	1.20	0.3	4.32	0.8
3	1.27	0.7	1.15	0.5	1.27	0.4
4	1.30	0.8	1.54	0.3	2.28	0.4
5	2.06	0.9	1.47	1.2	3.30	0.7
6	4.45	1.1	2.26	1.2	2.80	1.0
7	3.59	1.0	2.36	1.5	3.05	1.7
8	3.73	1.0	1.35	1.9	5.08	3.4
Total........	18.38	5.6	12.46	7.1	24.64	9.2

TABLE 3

Percentage of success in inarching pummelo seedlings, with different materials for tying

TYING MATERIAL	NO. OF INARCHES MADE	NO. OF LIVING INARCHES	PERCENTAGE OF SUCCESS
Cotton string............	20	18	90.0
Budding tape............	20	15	75.0
Electric tape............	20	9	45.0
Total..............	60	42	Average 70.0

EXPERIMENTAL CONTROL OF WATER HYACINTH IN LOWLAND RICE FIELDS WITH HERBICIDES[1]

G. O. Ocfemia and Silvestre V. Javier, Jr.[2]
Of the Department of Plant Pathology

WITH ONE TEXT FIGURE

In 1948, Capinpin and Ocfemia[3] reported that the water hyacinth (*Eichornia azurea* Kunth.) was one of the 49 species of nongraminaceous weeds which were killed by a single application of 1,000 p.p.m. (0.1 per cent) aqueous solution of 2,4-D. In an unnumbered mimeographed circular of the Department of Agriculture of New South Wales, Australia, a "complete kill" is reported of what they call the "World's Worst Weed" (*Eichornia crassipes*) by spraying with 0.1 per cent concentration of either Methoxone or one of the formulations of 2,4-D. In the March, 1950 issue of "Chemistry and Chemical Engineering in the United States," under the heading "Chemical Conquers Plant Foe of Inland Navigation," it is stated that the experiments of Edward C. Greco of the United Gas Pipe Line Company, Shreveport, Louisiana, gave complete control (99.9 per cent "kill") of water hyacinth with 2,4-D. The experiments were conducted in the summer (of 1949?) in canals in the marsh lands owned and operated by the Pipe Line Company near the southern coast of Louisiana.

The present paper summarizes briefly the results of the application of five brands of herbicides on water hyacinth growing in lowland rice fields. The work was conducted from June, 1948, to January, 1949, in the land of Mr. Faustino Marcelo in Santa Cruz, Laguna, and in the vicinity of the College of Agriculture Experiment Station at Los Baños.

MATERIALS AND PROCEDURE

Aqueous solutions of concentration (based on content of active ingredients) 0.05, 0.06, 0.1, 0.2, 0.5, and 1.0 per cent were prepared from each of five chemical weed killers[4] as follows:

1. 2,4-Dow Powdered Weed Killer with 90 per cent of active ingredient
2. 2,4-D Liquid Weed Killer with 40 per cent of active ingredient
3. Dow Selective Weed Killer
4. Dow Contact Weed Killer
5. Esteron 44

[1]Experiment Station Contribution No. 1553. An extract from the thesis of Silvestre V. Javier, Jr., entitled, "A Further Study of Weed Eradication with 2,4-D and Other Herbicides", presented in April, 1949, for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 1621. Prepared in the Department of Plant Pathology under the direction of the senior author.

[2]At present with the Division of Soil Conservation, Philippine Department of Agriculture and Natural Resources, Manila.

[3]Capinpin, Renato I. and G. O. Ocfemia. 1948. A study of weed eradication with 2,4-D in lawns, vacant lots, and pastures. Philippine Agriculturist **31**: 239–255. *Fig. 1–3.*

[4]Obtained through Dr. Ben Mapa from Getz Bros. & Co., Inc., Manila.

The different concentrations of these five weed killers were applied on each plot of 8 square meters of paddy which had a good growth of water hyacinth among the rice plants (fig. 1). In one set of the tests the solutions were applied directly on the water hyacinth and in the other, in the water in which the water hyacinth was growing. The herbicide solutions were applied on the water hyacinth with a No. 139 Hudson Clipper Sprayer at the rate of 1.6 liters to each plot of 8 square meters.

Fig. 1.—The effects of Esteron 44 on the water hyacinth *Eichornia azurea* Kunth. growing among rice plants in a lowland rice field: Upper panel: left, *Eichornia azurea* before treatment with 0.5 per cent aqueous solution of Esteron 44. Center, the same plants three days after treatment, showing the pronounced bending and twisting of the stems and the leaves lying on the water surface. Right, the same plants three weeks after treatment. Lower panel: left, *Eichornia azurea* with the rice plants shown before they were treated with 0.1 per cent aqueous solution of Esteron 44. Middle, the same plants three days after treatment. Right, the same plants showing a complete killing of the water hyacinth, whereas the rice plants regained their normal growth. (*All photographs by Silvestre V. Javier, Jr.*)

SUMMARY OF RESULTS

The water hyacinth plants growing among the rice stools in the paddies were killed by 0.1, 0.2, 0.5, and 1.0 per cent solutions of Esteron 44, 2,4-Dow Powdered Weed Killer, Dow Contact Weed Killer, Dow Selective Weed Killer, and 2,4-Dow Liquid Weed Killer. At these concentrations Esteron 44, 2,4-Dow Powdered Weed Killer, Dow Contact Weed Killer, Dow Selective Weed Killer, and Dow Liquid Weed Killer killed the water hyacinths and other nongraminaceous weeds in two to three weeks. Three

of the effective concentrations used were higher than the dilution (0.1 per cent) of 2,4-D reported in New South Wales for killing water hyacinth. Esteron 44, 2,4-Dow Powdered Weed Killer, and 2,4-Dow Liquid Weed Killer were more effective against the water hyacinth than the Dow Contact Weed Killer and Dow Selective Weed Killer. At the concentrations of 0.1, 0.2, and 0.5 per cent, the Dow Contact Weed Killer and Dow Selective Weed Killer required a second spraying in order to produce the effect caused by the other three herbicides.

As to the effect on the rice plants which we were trying to protect from the water hyacinth, it was noted that the rice plants in the treated paddies were not killed. They recovered faster from the injuries brought about by the 0.05, 0.06, and 0.1 per cent herbicide solutions than from the 0.2, 0.5, and 1.0 per cent solutions.

When Esteron 44, 2,4-Dow Powdered Weed Killer, Dow Contact Weed Killer, and 2,4-Dow Liquid Weed Killer were applied on the water of the paddies, the 0.1, 0.2, 0.5, and 1.0 per cent solutions did not kill the water hyacinths, owing perhaps to their much reduced concentrations. The higher concentrations 0.5 and 1.0 caused some injuries on parts of the rice plant and of the water hyacinth which were in contact with the treated water. They did not, however, kill the water hyacinth.

In this work no effort was made to note the effects on animal life of the different herbicide solutions applied on the water hyacinth in the lowland rice fields. Various workers in widely separated places in the United States have shown that 2,4-D is nonpoisonous to warm-blooded animals.

The effect of the various herbicides on nearby cultivated plants was not studied either. The influence of these growth-regulating substances on the neighboring crops is important to understand if these weed killers are to have a general application in Philippine agriculture.

RECOMMENDATION

Although the water hyacinth is apparently completely destroyed by a single application of 2,4-D and the five herbicides tested in this work when these are applied directly on the plants, other sprayings should be made for effectiveness. The intervals for the succeeding sprays are to be determined by the emergence of new growths from old roots or from seeds. These follow-up applications of the herbicide solutions are essential in preventing the re-establishment of the water hyacinth.

THE FRESH MEAT SUPPLY IN THE CITY OF BAGUIO[1]

VALENTE VILLEGAS
Of the Department of Animal Husbandry
AND
CIPRIANO A. FLORES
City Veterinarian, City of Baguio

WITH ONE TEXT FIGURE

A study was made of the fresh meat supply in the City of Baguio for the years 1947 and 1948, including carcasses of cattle, carabaos, horse, sheep, and goats.

The abattoir of the City of Baguio is located a short distance from the downtown district, on the right side of the road towards the Trinidad Valley. The compound is provided with one slaughterhouse, an office, animal sheds, and residences for the personnel. Livestock are placed for sale on an open space in the compound, pigs being kept in sties and baskets. Poultry are not handled in this station. For security purposes, animals are kept here for varying periods before slaughtering, the owners of the animals furnishing the feeds.

BREEDING AND SOURCES OF ANIMALS

Most of the cattle slaughtered are of native breed from Tabuk, Kiangan, Mountain Province, Abra, Pangasinan, La Union, Ilocos Sur, and Fuga Island. Most of them are old males. The better classes are from Ilocos Sur and Abra.

Swine are of two grades. The better grade has foreign blood. They come from Pangasinan and Ilocos Sur. The poorer kind is small, black and white, with long and pointed snout, small ears, narrow body, paunchy abdomen, and low back. The ham is deficient. This class comes from the provinces of Pangasinan, Ilocos Sur, La Union, and Abra. Pigs are not raised in the Mountain Province owing to insufficient supply of feed.

METHODS OF SLAUGHTERING

The city veterinarian makes an ante-mortem examination of the animals to be slaughtered. The certificate of ownership or certificate of transfer of large animals is examined.

Cattle are put in readiness for stunning by passing the lead rope through a ring on the floor of the slaughterhouse. This arrangement prevents the animal from goring anybody during the stunning. Cattle are struck with a sledge hammer on the top of the neck a little behind the poll. The first strike causes the animal to drop on the floor. The stunned animal is struck again on the same spot to stupefy it until it is hoisted. The animal is then

[1]General Contribution No. 795. Read by the senior author before the Los Baños Biological Club on July 29, 1949.

bled thoroughly, first, by cutting a slit alongside the throat and afterwards by severing the carotid artery. The blood is collected in a can. The carcass is skinned while it is hanging to keep it clean.

The hog is also stunned first by hitting it on the forehead with a wooden sledge hammer to do away with tying the legs and prevent struggling. The animal is then bled, scalded, and eviscerated in the usual manner.

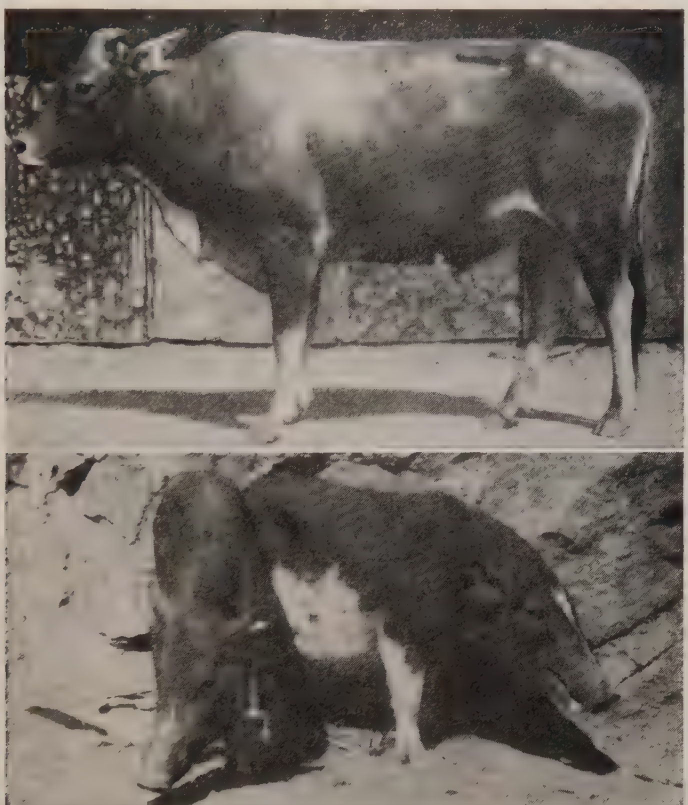


Fig. 1.—Upper panel: A native ox from Abra for slaughtering in the City of Baguio. The color is light black and the height is 111.8 cm. (44 inches). Lower panel: Native hogs being slaughtered in the City of Baguio abattoir. Note the long snout and long and narrow back. (*Photographs by courtesy of the Bureau of Plant Industry*).

FEES

In the slaughter of meat animals various fees are collected in the abattoir, namely: a national livestock fee of twenty centavos a head for small animals like the sheep, goat, and pig, and thirty centavos a head for large animals like the carabao, ox, and horse; a slaughter fee of fifty centavos a head for small animals and ₱1.00 for large animals; an abattoir fee of ten centavos a head a day for small animals and twenty centavos for large

animals; an inspection fee of two and one-half centavos a kilogram of the carcass of any class of animal; and a delivery fee of twenty-five centavos a carcass with small animals and sixty centavos with large animals. The livestock fee goes to the national coffers for use in the improvement of livestock. The rest of the fees constitute an income for the City of Baguio. The abattoir fee is collected in return for the safekeeping of animals in the corrals of the slaughterhouse and for the ante-mortem examination of the animal before slaughter.

Hogs are purchased by meat vendors from livestock dealers at prices ranging from ₱1.80 to ₱2.00 a kgm. dressed weight. A big overfat hog costs less a kilo dressed weight than a moderately fat but fleshy one. The entrails of hogs go free with the carcass in a dressed weight purchase.

Cattle when sold by livestock dealers by dressed weight cost from ₱1.90 to ₱2.10 a kgm. In weighing the carcass, the tongue, liver, and heart are included in the dressed-weight purchase. Entrails, tail, shank, head, and skin go free with the carcass. The tail and shanks are scalded and dehaired by slaughterhouse personnel before they are turned over to the meat vendors. The livestock dealers bear the total burden of loss of whole carcassess that are condemned.

Other fees collected by the abattoir are the daily livestock fee, municipal livestock license fee, registration and transfer fees of large animals, impounding fees, and anti-rabies vaccination fees. The daily livestock fee refers to the fee for animals sold at the livestock market situated close to the abattoir. Large animals are charged 50 centavos a head on the day of arrival. Afterwards, the fee is 20 centavos a head a day for both large and small animals. A municipal license fee of ₱12 a year is paid by anyone engaged in the buying and selling of animals. Impounded small animals are taxed 50 centavos a head a day and the large ones, ₱1. Vaccination of dogs against rabies is done at the abattoir at ₱1 a head and ₱2 elsewhere. Compulsory vaccination of impounded dogs against the same disease is made at ₱1.50 a head.

In 1948, the monthly slaughter fees ranged from ₱664 in February to ₱999 in May, the average being ₱787.21. The total amount collected for the year was ₱9,446.60. The inspection fees for the year were ₱16,-584.99, and the average monthly collection was ₱1,382.08. The minimum amount of fee was ₱1,184.75 collected in February and the maximum, ₱1,716.48, in May. The total collection for the delivery of meat was ₱6,-244.21 for the year, the range being from ₱391.96 in October to ₱722.15 in May. The average amount was ₱520.35 a month.

NUMBER OF ANIMALS SLAUGHTERED

The total number of cattle slaughtered in 1947 was 1,931. The average number butchered in a month was 160.9 head, or 8.3 per cent. The highest number butchered, or 10.9 per cent of the total number, was in May; the lowest percentage was 7.1, in September.

The total amount of beef produced in 1947 was 193,132 kilograms, the average production in a month being 16,094.3 kilograms. December, with 10.64 per cent, registered the highest figure and February, with 7.03 per cent, the lowest.

In 1948, the aggregate number of cattle slaughtered was 2,074, or 143 head more than in 1947. The highest percentage of animals butchered a month (10.9 per cent) was registered in May, and the lowest (6.4 per cent) in February.

The amount of beef produced in 1948 was 217,188 kilograms, the monthly production being 18,099 kilograms, or 24,056 kilograms more than in 1947. The month of May had the highest percentage of beef, with 10.3 per cent, and October, with 5.4 per cent, the lowest.

Of pigs, 11,623 head were slaughtered in 1947; the average number a month was 968.6 pigs. The highest percentage of animals butchered was in December, 11.0 per cent of the total and the lowest in February, 6.6 per cent. The average monthly percentage was 8.3.

The amount of pork produced in 1947 was 360,134 kilograms, the average monthly production being 30,011.1 kilograms. December gave the highest production of 10.8 per cent and February, the lowest with 6.1 per cent.

The total number of pigs butchered in 1948 was 14,945, with an average of 1,245.4 a month, or 3,322 head more than in 1947. The highest percentage of butchered pigs was in May (10.4 per cent) and the lowest (7.1 per cent), in February.

The amount of pork produced in 1948 was 438,771 kilograms; the monthly average was 36,564.3 kilograms. The 1948 pork production was 78,637 kilograms more than that in 1947. The production for May was highest, with 10.5 per cent, and that for September was lowest, with 7.3 per cent.

OTHER ANIMALS

One horse, five carabaos, and 91 goats were slaughtered in 1948. They yielded 54 kilograms of horse meat, 415 kilograms of carabao meat, and 457 kilograms of chevon, respectively.

SIZE OF CARCASSES

In 1947, 60.3 per cent of all beef carcasses weighed below 100 kilograms; the mean weight was 77.4 kilograms. Of the carcasses, 29.8 per cent weighed between 100 and 149 kilograms, with a mean weight of 120 kilograms. Only 9.9 per cent of the carcasses were 150 kilograms and over; the mean weight was 168.4 kilograms.

In 1948, the first group of carcasses had a mean weight of 79.8 kilograms, or 47.3 per cent; the second group a mean weight of 120.7 kilograms, or 38.8 per cent; and the third group a mean weight of 170.9 kilograms, or 13.9 per cent. The carcasses are arranged in the ascending order of their weights as in 1947.

In 1947, 67.6 per cent of 5,401 pig carcasses weighed from 20 to 39 kilograms, mean, 29.6; 19.0 per cent, from 40 to 59 kilograms, mean, 51; 5.4 per cent, below 20 kilograms, mean, 17.1; 5.2 per cent, from 60 to 99 kilograms, mean, 68.0; 1.7 per cent, from 80 to 99 kilograms, mean, 88.2; and 1.1 per cent, 100 kilograms and over, mean, 125.2.

In 1948, 69.5 per cent of the pig carcasses were between 20 and 39 kilograms; the mean weight was 29.4 kilograms. The carcasses next to this group, with a mean weight of 44.0 kilograms formed 19.4 per cent. The carcasses with a mean weight of 16.6 kilograms, were 8.04 per cent and those with a mean weight of 67.0 kilograms, 2.08 per cent. The carcasses with a mean weight of 87.0 kilograms formed 0.72 per cent and those 112.5 kilograms, 0.24 per cent.

From September, 1922 to February, 1924, Manuel[2] found that in the Manila slaughterhouse, the average dressed weight of cattle from Ilocos Sur was 153 kilograms and that from Fuga Island, 50 kilograms.

Of swine butchered in the Manila slaughterhouse in 1923 and 1924, Rodriguez, Jr.[3] found that the dressed weight of barrows weighed, on the average, 32.5 kilograms and that of the sows and pigs, 36.4 kilograms.

Elazegui[4] found that 83.5 per cent of the barrows and 89.6 per cent of the gilts slaughtered in Calamba, Laguna, weighed from 30 to 59 kilograms.

CONDEMNED PARTS OF CARCASSES AND ORGANS

In 1947, 119 pieces of the liver and two pieces of the intestines of cattle were condemned.

In the pigs, the following were declared unfit for food: pieces of lungs with parts congested, emphysematous, or bloody; worm-infested kidneys; liver which showed tuberculosis, cirrhosis, fatty degeneration, or parasitized; either congested or parasitized intestines; congested stomach; and tuberculous parotid salivary and lymph glands. In 1947, a total of 2,705.5 parts of pig carcasses were discarded; 1,035, or 38.3 per cent had lung lessions, and 979, or 36.2 per cent, had diseases of the liver; 85.5 pig carcasses had leg contusions; 26 cysticercosis; 5 septicemia; 3 hog cholera; 2 rope burn involving the leg; and one case each of cyst, gastro-enteritis, and cold.

In 1948, parasitized intestines registered the highest incidence in cattle, 678, or 20.1 per cent of the total number. Next was liver fluke with 514 cases, or 15.3 per cent. Congestion in the lungs had 474 cases, or 14.1 per cent. Parasitized liver was also high with 434 cases, or 2.9 per cent. Other cases included leg contusions with 328 cases, or 9.7 per cent; hemorrhagic lungs with 267 cases, or 7.9 per cent; cirrhosis with 225 cases, or 6.7 per cent; emphysematous lungs with 171 cases, or 5.1 per cent; and congestion in the stomach with 147 cases, or 4.4 per cent.

In 1948, a total of 1,691 head of hogs, or 1.11 per cent, were found affected with abscess or localized tuberculosis. The lymph glands affected were removed, including a good healthy portion, and the head cut from the carcass. The heads were then sterilized by boiling for thirty minutes before turning them over to owners who sell them at reduced prices.

---

[2]MANUEL, CANUTO G. 1925. A study of the meat supply of the City of Manila. Philippine Agriculturist **14:** 93–110.

[3]RODRIGUEZ, JR., EULOGIO. A study of the pork supply in the City of Manila. Philippine Agriculturist **15:** 233–241.

[4]ELAZEGUI, MAGDALENO R. The relation of the dressed weight of market hogs in Calamba to their live weight and to the weights of the wholesale cuts. Thesis presented for graduation, March, 1948, with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Unpublished.

In the same year, whole carcasses of 59 pigs, or 0.4 per cent of all pigs slaughtered, were condemned. Thirty-five of them had cysticercosis and 24, hog cholera.

The total number of condemned pieces of organs in 1948 was 7,557. Of these, 1,697 pieces, or 22.0 per cent, were discarded on account of lung congestion. Parasitized liver was present in 924 parts, or 12.2 per cent. There were 856 pieces, or 11.3 per cent, of hemorrhagic lungs, 777 parts of the kidney, or 10.3 per cent, with kidney worms. Contused legs were common; there were 729 cases, or 9.6 per cent. Liver tuberculosis was also found in 546 cases, or 7.2 per cent.

Manuel[5] noted that the most common cause for condemning parts of carcass among cattle in the Manila slaughterhouse, from 1919 to 1922, was congestion, whereas in pigs, hypostatic congestion.

SUMMARY

1. A study was made on the fresh meat supply in the City of Baguio for the years 1947 and 1948. The study included carcasses of cattle, carabao, horse, sheep, pigs and goats.

2. Most of the cattle slaughtered were old and native males from Tabuk, Kiañgan, Mountain Province, Abra, Pangasinan, La Union, Ilocos Sur, and Fuga Island. The better classes came from Ilocos Sur and Abra. Swine were of the native breed and grades from Pangasinan and Ilocos Sur.

3. In slaughtering, both the cattle and the pigs were first stunned with a hammer on the forehead before they were bled to prevent them from struggling and injuring the butchers.

4. The fees charged for slaughtering animals consist of the national livestock fee for the improvement of the livestock, and other fees which go to the coffers of the City of Baguio.

5. The total number of cattle slaughtered in 1948 was 2,074, or 143 more than in 1947. The amount of beef produced in 1948 was 217,188 kilograms, or 24,056 kilograms more than that in 1947.

6. The total number of pigs slaughtered in 1948 was 14,945 head, or 3,322 head more than in 1947. The amount of pork obtained in 1948 was 438,771 kilograms, or 78,637 kilograms greater than in 1947.

7. Carabaos, goats, and a horse were also slaughtered in 1948, but the amount of meat from these was small.

8. Most of the beef carcasses weighed less than 100 kilograms; the mean weights were 77.4 kilograms in 1947 and 79.8 kilograms in 1948. The carcasses next in frequency were between 100 and 149 kilograms; the mean weights were 120 kilograms in 1947 and 120.7 kilograms in 1948. A small percentage of carcasses weighing 150 kilograms and over were obtained, with mean weights of 168.4 kilograms in 1947 and 170.9 kilograms in 1948.

9. The most frequent size-group of pig carcasses in 1947 weighed between 20 and 39 kilograms, with a mean weight of 29.6 kilograms, and

---
[5] *Op. cit.*

in 1948 with a mean weight of 29.4 kilograms. The carcasses of the next group were between 40 and 99 kilograms. The mean weight in 1947 was 51 kilograms and in 1948, 44 kilograms. A small percentage of the carcasses in both years weighed below 20 kilograms, the mean weight being 17.1 kilograms in 1947 and 16.6 kilograms in 1948. The third size-group for both years weighed between 60 and 99 kilograms, with a mean weight of 88.2 kilograms in 1947 and 67.0 kilograms in 1948. Large carcasses 100 kilograms and over constituted the smallest percentage; the mean weight in 1947 was 125.2 kilograms and in 1948, 112.5 kilograms.

10. Liver fluke and parasites in the intestines were the common causes for discarding parts of affected carcasses in cattle. The common causes for the elimination of parts of carcasses and organs of pigs were congestion in the lungs, parasite in the liver, hemorrhagic in the lungs, and kidney-worm infestation. Of pigs slaughtered in 1948, 0.4 per cent of whole carcasses were condemned on account of cysticercosis and hog cholera. In the same year, 1.11 per cent were found affected with localized tuberculosis.

COLLEGE AND ALUMNI NOTES

A meeting of the Laguna Chapter No. 1 of the U. P. Alumni Association was held at the Agricultural Chemistry Lecture Hall on January 30, 1950. The members approved to extend the term of office of the prewar officers until a regular election is held. It was decided that the chapter be made to include the entire Laguna instead of the Los Baños district only. For this purpose, Dr. F. O. Santos, president, appointed a committee, with Dr. F. M. Sacay as chairman, to study ways and means of extending membership to all U. P. alumni residing in Laguna.

The committee on reorganization met on February 19, 1950. The members who attended were: Dr. F. M. Sacay, '25, chairman; and Colonel Nemesio Catalan, '20, and Professor Eugenio de la Cruz, members. After the meeting, a luncheon was offered by Dr. F. O. Santos, '19, the president of the chapter, to the members of the committee and others, including Dr. L. G. Gonzalez, '22, and Dr. J. M. Capinpin, '20.

A portrait of Dean Edwin Bingham Copeland, painted in the United States and sent from San Francisco by air express, has been received by Dr. Felipe T. Adriano, '19. The portrait is donated to the College by the alumni and will be installed at the Dean's Office. In a letter of appreciation, Dean Copeland expressed his gratitude to the alumni for the portrait and for all his former students have done for him.

Dr. F. W. Foxworthy, a former member of the faculty during the early days of the College, recently died of heart failure, according to advices received from Dean E. B. Copeland by Professor Harold Cuzner of the College of Forestry.

Dr. and Mrs. Robert L. Pendleton, Dr. and Mrs. Harry Love, Mr. John V. Hepler, and Mr. Cornelio V. Crucillo were campus visitors on March 14, 1950. Drs. Pendleton and Love and Mr. Hepler spoke at a special convocation.

Doctor Pendleton was formerly head of the Department of Soils of the College. Doctor Love, professor of plant breeding at Cornell University, has been working in various countries in the past years, where he has contributed to increased crop yields through production of improved varieties and strains of plants.

Dr. Poorwo Soedarmo, director of the Institute of Nutrition of the Republic of the United States of Indonesia, accompanied by Dr. Juan Salcedo, Jr., director of the Philippine Institute of Nutrition, visited the College on March 20, 1950. They were entertained by Dr. F. O. Santos, member of the Institute of Nutrition Board.

Mr. José F. Zamora, '11, taxicab operator, and Mr. Demetrio S. Santos, '36, president of the Philippine Association of Agriculturists, were cited for outstanding contribution to business and industry during 1949 at the annual business awards dinner held on March 26, 1950, under the auspices of the Business Writers' Association of the Philippines.

The 192nd scientific meeting of the Los Baños Biological Club was held on March 31, 1950 at the Agricultural Chemistry Lecture Hall. The following paper was read and discussed: "Suggested Changes in Determining the Allowable Cut Applicable to Philippine Dipterocarp Forest," by Forester Nicanor P. Lalog of the Division of Forest Investigation and College of Forestry.

Dr. A. H. Moseman, of the Plant Industry Station, Beltsville, Maryland, and Mr. P. V. Kepner, of the Extension Service, U. S. Department of Agriculture, visited the campus on April 17, 1950. They conferred with Dean Uichanco and several faculty members regarding President Truman's Point IV Program.

The visitors were accompanied by Mr. Merrill W. Abbey, Agricultural attaché, U. S. Embassy, Mr. John V. Hepler, Dr. Amando M. Dalisay, and Mr. Cornelio V. Crucillo.

The College faculty, in a meeting on April 11, 1950, approved to recommend to the University Council the graduation of 36 students for the degree of Bachelor of Science in Agriculture and three students for the title of Associate in Agriculture. They were as follows: for the B.S.A. degree—Wilfredo G. Agne, Alejandro R. Alcaide, Jesus de la Cruz Alix, Majindi K. Anuddin, Juanito L. Baliao, Inocencio P. Ballesteros, José L. Berenguer, Jr., Aguinaldo J. Bueno, Demetrio M. Cabantac, Pio C. Catalon, David Ma. Daza, Alfonso B. Diñgayan, Diomedes G. Flores, Guillermo M. Francisco, Jr., Roberto E. Fronda, Alfredo B. Galang, Augusto S. Gonzalez, Macario T. Ilaga, Renato B. Jagunap, Juanito C. José, Alfredo B. Magnaye, Francisco B. Magnaye, Jesus M. Martinez, Francisco E. Mercado, José M. Panique, Crispulo Q. Quibin, Genaro O. Ranit, Guadalupe A. Rola, Florante C. Salvador, Mario O. San Juan, Antonio U. Serraon, Armando C. Siason, Leandro G. Sinco, Magin Llanera Soriano, Quintin L. de la Torre, and Silverio P. Villa; for the title of Associate in Agriculture—Felicidad M. Mañgali, Eliseo T. Trinidad, and Earl Lewis Redfield.

The Maquiling School held an open house and program on April 3, 1950, at its newly reconstructed building. The U. P. Rural High School held its open house and field day on April 13.

Mr. John V. Hepler, of the Office of Foreign Agricultural Relations, U.S.D.A., was the guest speaker at the 19th commencement exercises of the U.P. Rural High School, which was held at the Agricultural Chemistry Lecture Hall on the morning of April 15, 1950. President B. M. Gonzalez distributed the diplomas to 51 members of the graduating class. Marcos de Vega, Jr. was the valedictorian in the boys' curriculum and Concepcion Valera, in the girls' curriculum.

The 24th closing exercises of the Maquiling School was held on the morning of April 22, 1950 at the Agricultural Chemistry Lecture Hall. Dean Uichanco distributed certificates to 23 new graduates.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS AS OF JANUARY, 1950

No. 2.—Bud Rot of Coconut .... *By G. O. Ocfemia*

No. 8.—Horse Breeding in the Philippines .... *By V. Villegas*

No. 10.—Practical Directions for Coffee Planting (Revised by Charles Fuller Baker, Dean, College of Agriculture, 1917-1927.) .... *By Pedro A. David*

No. 11.—The New College Copra Drier—Prepared in the Department of Agricultural Chemistry with the cooperation of the Department of Agronomy and Extension. (Revised) .... *By Moises M. Kalaw*

No. 17.—College Trapnest .... *By F. M. Fronda and P. S. Paje*

No. 18.—Surveying for Area with a Surveyor's Staff .. *By Alexander Gordon*

No. 23.—Curing Pork and Making Sausage for Home Use .... *By Mariano Mondoñedo*

No. 24.—Construction and Operation of Silos in the College of Agriculture .... *By J. P. Esguerra*

No. 26.—Training Cattle and Carabaos for Work .... *By Valente Villegas*

No. 28.—Cotton Culture .... *By Eulalio P. Baltazar*

No. 29.—Collegiate Education in Agriculture ...... *By Leopoldo B. Uichanco*

No. 30.—What Should Filipino Ornamental Gardens and Ornamental Plants Be? .... *By N. B. Mendiola*

The price of the circulars listed above is thirty centavos (₱0.30) each.

ALL ORDERS WITH PAYMENT SHOULD BE ADDRESSED TO THE BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, COLLEGE, LAGUNA, PHILIPPINES.

The Philippine Agriculturist

(Formerly The Philippine Agriculturist and Forester)

Published by the COLLEGE OF AGRICULTURE
UNIVERSITY OF THE PHILIPPINES

Vol. 1—2

Vol. III—9-10

Vol. IV—3, 5-6, 7

Vol. V—2, 3, 5, 6, 7, 8, 9, 10

Vol. VI—complete

Vol. VII—complete

Vol. VIII—3, 4, 5, 6, 7, 8-9, 10

Vol. IX—3, 4-5, 8-9

Vol. XI—3, 4, 5, 6, 7, 8

Vol. XIII—1, 3, 4, 5, 6, 8, 10

Vol. XIV—complete

Vol. XV—complete

Vol. XVI—complete

Vol. XVII—6, 7, 8, 9, 10

Vol. XVIII—complete

Vol. XIX—complete

Vol. XX—complete

Vol. XXI—complete

Vol. XXII—complete

Vol. XXIII—complete

Vol. XXIV—complete

Vol. XXV—complete

Vol, XXVI—complete

Vol. XXVII—complete

Vols. XXVIII, XXIX and XXX—burned

Separate indices to Vol. 1 to XXVI

Consolidated index to Vol. I to XX

Back copies sell at 50 centavos.

Consolidated index 50 centavos excluding postage.

Send your order to the BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, COLLEGE, LAGUNA, PHILIPPINES.